VOL. 4 NO. 15
August 15, 1979

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ABSTRACTS 40052-42150

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Volume 4, Number 15, August 15, 1979
ISSN: 0160-3604
CODEN: ERABDZ

ENERGY RESEARCH ABSTRACTS

Published by the **Technical Information Center, Oak Ridge, Tennessee**
United States Department of Energy

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(BAW—10074A(Rev.1))
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The Secretary of the U. S. Department of Energy has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this agency. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through June 30, 1978.

Volume 4, Number 15, August 15, 1979

ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

40052 (ORNL/EIS—120(Vol.1)) **Inventory of coal research and development.** Caton, G.M.; Michelson, D.C.; Collier, B.N.; Cooper, J.B.; Danford, G.S.; Frogge, L.M.; Hamley, R.J.; McDuffie, R.A.; Owen, P.T. (Oak Ridge National Lab., TN (USA)). May 1979. Contract W-7405-ENG-26. 418p. Dep. NTIS, PC A18/MF A01.

This is the first publication of the Fossil Energy Information Program repored from information obtained in a nationwide survey conducted from September 1977 to April 1978. Information was received on over 15,000 energy and energy-related R and D projects in progress from 1976 through 1978. Over two thousand of these projects are concerned with coal research and development. General information and statistical summary tables of funding and manpower are provided for these selected projects. Basic information on all 15,000 projects is available on the Department of Energy's RECON (Remote Console) computer system. Each of the 2,031 research project descriptions in this publication is related to one of the following Coal and Coal Products Categories: Processing, By-Products, Properties, Waste Management, Environmental Aspects, Reserves and Exploration, Mining, Transportation and Handling, Combustion, Marketing and Economics, Health and Safety, or Regulations. To eliminate the necessity of listing a project description in more than one place, a cross-referencing system has been utilized. Each research project has one primary category and appears only once in the inventory.

40053 (ORNL/EIS—120(Vol.2)) **Inventory of coal research and development.** Caton, G.M.; Michelson, D.C.; Collier, B.N.; Cooper, J.B.; Danford, G.S.; Frogge, L.M.; Hamley, R.J.; McDuffie, R.A.; Owen, P.T. (Oak Ridge National Lab., TN (USA)). May 1979. Contract W-7405-ENG-26. 395p. Dep. NTIS, PC A17/MF A01.

Volume 2 contains part of the list of research projects, a list of research institutes and sponsors, a list of investigators, a keyword index, a research location index, a permuted title index, and an appendix listing bulk information sources. (LTN)

PROCESSING

REFER ALSO TO CITATION(S) 41010, 41089, 41109, 41468

40054 (M—78-68(Vol.2), pp 107-115) **Anthracite culm—anthracite combustion program.** Geffken, J. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The U.S. Department of Energy has initiated a program to develop and demonstrate anthracite culm—anthracite combustion technology using fluidized bed combustion or other processes that will burn culm in an environmentally acceptable manner. The value of anthracite culm as a fuel source is specific to the anthracite region. However, the technology to be developed and demonstrated will be applicable to the utilization of many other waste and/or low Btu fuels. In the anthracite region the culm banks are aesthetic eyesores, which cover valuable real estate that is in short supply in that area. It is the intent of this program to address steam generation and/or process air heating applications. An important factor in this program will be to define the transportation economics for delivering culm to specific sites with or without reworking to increase the Btu/lb value both before and after shipment. This will be essential information needed for commercial implementation of the demonstrated technology at specific sites at or adjacent to the culm pile areas.

DESULFURIZATION AND PURIFICATION

REFER ALSO TO CITATION(S) 40089, 40111, 40112, 40191, 40795, 40811

40055 (FE—0496-T9) **Solvent refined coal (SRC) process. Research and development report No. 53: interim report No. 18, 1975. Development of a process for producing an ashless, low-sulfur fuel from coal. Volume IV: product studies. Part 9: an investigation of the activity of two Cobalt-Molybdenum-Alumina catalysts for hydrodesulfurization of a coal-derived liquid.** Ahmed, M.M. (Oklahoma State Univ., Stillwater (USA); Pittsburg and Midway Coal Mining Co., Shawnee Mission, KS (USA)). Jan 1979. Contract EX-76-C-01-0496. 127p. Dep. NTIS, PC A07/MF A01.

Thesis.

Two Cobalt-Molybdenum-Alumina catalysts, Sphericat Nalco 474 and Nalcomo 474 having bimodal and unimodal pore size distribution respectively, were studied for hydrodesulfurization (HDS) of FMC oil in a trickle bed reactor. Experimental data were taken at 1500 psig, 2.99 liquid volume hourly space time, 7500 standard cubic feet hydrogen per barrel of FMC oil for temperatures of 700°F, 800°F, 850°F using Sphericat Nalco 474 catalyst and for 700°F and 800°F using Nalcomb 474 catalyst. The experimental system carried out successful operation at 850°F for 145 hours. Under the operational conditions of this study, sulfur concentration in the product oils of 0.02 wt% was observed. However, the presence of macropores in Sphericat Nalco 474 catalyst provided no advantage over the micropores alone in Nalcomo 474 catalyst. Both the catalysts maintained their activity during the entire period of operation of a particular run, the duration of which varied from 100 to 200 hours.

40056 (FE—2034-14) **Catalytic hydrogenation of coal-derived liquids. Interim report, December 1973—February 1979.** Berg, L.; McCandless, F.P. (Montana State Univ., Bozeman (USA)). Mar 1979. Contract EX-76-C-01-2034. 47p. Dep. NTIS, PC A03/MF A01.

Five additional commercial hydrotreating catalysts were investigated with SRC-II during the quarter with NALCO 502 nickel molybdate giving the best denitrogenation (60%) and NALCO 477 cobalt molybdate giving the best desulfurization (73%). Thirty-two different catalysts were fabricated during the quarter involving combinations of cobalt, nickel, molybdenum, and tungsten on bases of silica—alumina—phosphorous oxide with surface areas ranging 147-323 m^2/g and pore diameters ranging 89-186 A. The best result, 77.6% denitrogenation and 74.8% desulfurization was obtained with a tungsten, cobalt, nickel impregnated alumina having 232 m^2/g surface area, 0.72 cc/g pore volume and 124A average pore diameter.

40057 (FE—2428-T1) **Development of a particulate control cyclocentrifuge. Phase II: laboratory tests. Test plan.** Albrecht, P.R. (Mechanical Technology, Inc., Latham, NY (USA)). 7 Jul 1978. Contract EX-76-C-01-2428. 9p. Dep. NTIS, PC A02/MF A01.

A study recently completed as Phase I effort predicts that a device combining the principles of a centrifuge with a cyclone, termed the CYCLOCENTRIFUGE, can provide a sufficient degree of gas-cleanup at high temperature and pressure to meet the most stringent particle-removal specifications for a very difficult application - the cleanup of gas turbine fuels. The objective of the present phase of this contract, Phase II, was to construct and test a Cyclocentrifuge laboratory model for the purpose of verifying the analytical predictions made in Phase I. Because of budget and schedule limitations, only one laboratory Cyclocentrifuge unit was manufactured. Based on design study reviews, the requirement for unquestionable mechanical integrity was given priority over the desire to achieve a design which would incorporate means for adjusting the

orientation and location of key aerodynamic components. This resulted in a manufacturing process whereby the swirl augmentation rotor was machined from a forging and welded to rigid support hubs. For the laboratory model, this manufacturing approach was found also to be the lowest cost procedure. Although the selected manufacturing approach eliminates uncertainties with respect to component alignment, potential loose parts, and joint stresses, use of this design in a test program will not determine the optimum Cyclocentrifuge design parameters. However, the prime Phase II test objective - which is to prove the Cyclocentrifuge separation principle - will be achieved by the test plan outlined below.

40058 (M—78-68(Vol.3), pp 347-360) **Particulate analysis instrumentation for advanced combustion systems.** Muly, E.C.; VanValkenburg, E.S. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

An on-line particulate analysis instrument has been developed by Leeds and Northrup Company under ERDA sponsorship for monitoring the concentration and size distribution of particles in the gas clean up stage of advanced combustion systems. This instrument utilizes low-angle forward scattering of laser illuminated particles by across-the-duct measurements. A prototype instrument has been tested on a fluidized-bed combustion system at the Argonne National Laboratory. This paper presents a brief description of this instrument and discusses the results obtained from the Argonne tests.

40059 (METC/CR—79/3) **Coal processing for fuel cell application; task report, November 6, 1978—January 15, 1979. Modeling of wet gas cleanup.** Bloomfield, D.; Simons, G.A.; Finson, M.L.; Wray, K.L. (Physical Sciences, Inc., Woburn, MA (USA)). Jan 1979. Contract EW-78-A-21-8450. 63p. Dep. NTIS, PC A04/MF A01.

The removal of tars and particulate materials from the effluent stream of a coal gasifier is of major importance in both a power generation sense and in an environmental sense. Gas cleanup systems represent a major cost item in powerplant design and their effective operation is crucial to the successful operation of coal gasifier powerplants. This is true whether the power generating unit is a fuel cell or one of the more conventional generators. The wet gas cleanup system presently under study by the Morgantown Energy Technology Center is an attractive approach to tar, particulate and sulfur removal. This report presents a preliminary analysis of four of the components used in the METC wet gas cleanup system. These components are: the humidification chamber, the disengagement changer, spray nozzles and final filter.

40060 **Coal desulfurization.** Hsu, G.C. (to California Inst. of Tech.). US Patent 4,146,367. 27 Mar 1979. Filed date 16 Feb 1978. 6p.

Organic sulfur is removed from coal by treatment with an organic solution of iron pentacarbonyl. Organic sulfur compounds can be removed by reaction of the iron pentacarbonyl with coal to generate CO and COS off-gases. The CO gas separated from COS can be passed over hot iron filings to generate iron pentacarbonyl.

40061 **Trace sulfur compound removal for coal gasification.** Lorenzi, L. Jr.; Mulvihill, J.W.; Peters, W.C. (Pittsburgh Energy Research Center, PA). pp 901-913 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Use of a metal-impregnated activated carbon system for trace sulfur control in synthetic gas from coal plants can achieve the desired control of sulfur species for protection of sensitive methanation catalysts. However, the economic position of this adsorption technique must be compared with the use of alternatives such as hydrolysis of the sulfur species to H_2S prior to bulk sulfur removal, use of alternative sorbents, etc. Additionally, further research needs to be performed to extend the trace-sulfur-removal data on both activated carbon and other adsorption systems and also to determine the extent to which hydrolysis is achievable in shift conversion operations and with catalytic materials designed specifically for hydrolysis of sulfur compounds.

HYDROGENATION

REFER ALSO TO CITATION(S) 40081

GASIFICATION

REFER ALSO TO CITATION(S) 40057, 40059, 40061, 40107, 40114, 40177, 40189, 40256, 40260, 40490, 40806, 41110, 41111, 41217, 41270

40062 (ANL—78-62) **Proceedings of the 1978 symposium on instrumentation and control for fossil demonstration plants.** (Argonne National Lab., IL (USA)). 1978. Contract W-31-109-ENG-38. 804p. (CONF-780656—). Dep. NTIS, PC A99/MF A01.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

The 1978 symposium on instrumentation and control for fossil demonstration plants was held at Newport Beach, California, June 19—21, 1978. It was sponsored by Argonne National Laboratory, the U.S. Department of Energy - Fossil Energy, and the Instrument Society of America - Orange County Section. Thirty-nine papers have been entered individually into the data base. (LTN)

40063 (ANL—78-62, pp 10-15) **Overview of the DOE Coal Conversion Program.** Lievens, E.J. Jr. (Dept. of Energy, Washington, DC). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

DOE's Fossil Energy Coal Program has two main thrusts. One is conversion, which derives from the coal a gaseous or liquid product for use in downstream processes. The other is utilization, which is primarily the direct combustion of coal resulting in a high-temperature working fluid such as steam. The processes surrounding both conversion and utilization must be done in a way that is economical and satisfies the most stringent environmental constraints. The typical approach practiced by DOE involves first bench research, then large units called process development units, pilot plant research, and finally eventual construction and operation of large demonstration plants. Demonstration plants are usually joint ventures with the private sector and are the last step before making a decision on commercialization. It is at this point that the capability and ability to understand and control the process are paramount. It is this know-how that permits ready commecialization of a specific technology once facets of operability and economics are developed.

40064 (ANL—78-62, pp 18-23) **Overview of coal conversion and instrumental/control requirements: an industrial view of processes and scale up.** Detman, R.F.; Walsh, J.V. (C.F. Braun and Co., Alhambra, CA). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

One of the major tasks confronting the designer of coal conversion processes is the evaluation of the ability to measure and control process parameters. The present day availability of required instrumentation is discussed in terms of performance, reliability, safety, and economy. Areas in which the performance of available instrumentation is inadequate are discussed and suggestions for additional development are made. The responsibility of the process designer in defining process measurements is outlined.

40065 (ANL—78-62, pp 26-42) **Progress in instrumentation and control for coal conversion since the 1977 symposium.** Lau, T.K. (Dept. of Energy, Washington, DC). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

According to a 1975 study by the Argonne National Laboratory (ANL) areas of deficiency include measurement of mixed solids/gas or solids/liquid mass flows; entrained particulate measurements; on-stream analysis of process streams; level measurement for fluidized beds and oil/water interfaces; and temperature measurement. We are doing everything we can to identify instruments already available which can meet these needs. Since last year, there has been a great deal of progress in meeting the instrumentation and control needs of the coal conversion processes, particularly in mixed-phase mass flow measurement.

40066 (ANL—78-62, pp 66-90) **HYGAS experiment on the feasibility of acoustic/ultrasonic flowmeters.** Raptis, A.C.; Sheen, S.H.; Mech, J.F.; Roach, P.D.; Popper, G.F. (Argonne National Lab., IL). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

During two test runs of the HYGAS coal conversion pilot plant, acoustic data from the low pressure slurry line were obtained. The data consist of the acoustic noise background and the sound transmission loss for the cases of 0%, 18%, and 33% coal by weight in toluene and benzene. Spectra of noise background were scanned from 10 kHz to 1 MHz. Most acoustic energy of the noise background was shown to be below 500 kHz. Relative sound transmission losses were measured by the pitch-catch pulse mode operation over the frequency range of 100 kHz to MHz. It was observed that the transmission losses depend strongly on coal concentration. Results of the present data are discussed in terms of the sonar equation,

and indicate that an ultrasonic or acoustic device is feasible for coal conversion process streams.

40067 (ANL—78-62, pp 92-113) **Measurement and control of solids in dilute and dense phase of advanced fossil fueled systems.** Geraci, E.E. (Leeds and Northrup Co., North Wales, PA). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

This paper describes the measurement of solids in both dilute and dense phase conditions of fossil fuel pilot plants. Two installations of different instrumentation are described. One is the measurement of finely pulverized coal blended in a coal-oil slurry (50% coal by weight in No. 6 oil) at a fuel preparation pilot plant. The measurement is used to determine consistency of grind, settling and agglomerating characteristics. The other instrumentation system monitors and controls the concentration level (1 to 1000 ppM) and size (1 to 50 microns) of injected solids in the fuel line of a gas turbine. This is used in a gas turbine erosion study project to develop turbines suitable for use in combined cycle power plants using coal derived synthetic fuels.

40068 (ANL—78-62, pp 132-154) **Energy transfer potentials in coal conversion instrumentation.** Liptak, B.G. (Liptak Associates, Stamford, CT). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

In any new processing technology such as is the coal conversion field, it is desirable to take advantage of the past experience which exists in similar industries. By utilizing the technological fallout from similar processes, one can speed up the progress of coal conversion technology and simultaneously concentrate on those few areas of instrumentation and process control where existing hardware or control experience is lacking. A relatively new concept in process control is the envelope control strategy. In envelope control systems the various process properties such as flow, pressure, and level are being looked upon as only constraints of the process. Each of these variables are identified with an acceptable operating range. As long as the process is inside that acceptable range for each of the process constraints, it is considered to be within the control envelope. Under such conditions the process can be optimized by maximizing the conversion of the Btu's in the coal into the Btu's in the coal gas. Thereby the envelope control strategy allows one to control the efficiency of the process and the individual process variables. This does make good sense because the purpose of the process is not to generate certain levels, temperatures, or pressures but to produce coal gas at a high efficiency. Another advantage of the envelope control system is its inherent dual set-point. By having two set-points and an acceptable gap between them, the process becomes stabilized and cycling due to unstable operation is eliminated. Yet another advantage of this control strategy is, that the number of control valves does not have to equal the number of process variables one wishes to control.

40069 (ANL—78-62, pp 156-164) **Mass flowrate measurement through gamma transmission—correlation processing.** Porges, K.G.; Doering, R.W. (Argonne National Lab., IL). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

On-line mass flow measurement under environmental conditions which preclude use of conventional equipment has to rely on concurrent measurements of medium density and flow velocity together with on-line computation of the mass flowrate from this information. Several types of sensors, deployed in an upstream/downstream pair, appear suitable for velocity determination through correlation. Density measurement is at present practically limited to gamma transmission. An accurate density measurement must allow for the effect of density fluctuations, which is discussed here. The same effect can also be employed in a flow/no-flow meter, using simple processing electronics and a single sensing channel. Accuracy is also enhanced by using NaI(Tl) scintillation channels rather than conventional ionization chambers. Current development work at Argonne National Laboratory (ANL) of scintillation detectors suitable for industrial deployment is briefly described. Digital processing, display, and storage of mass flowrate requires a microprocessing system of high speed as well as efficient programming. To be effective in an industrial plant, the whole system must operate autonomously and track the mass flowrate from startup to full flow. Development of such a system has just started at ANL; as planned, the processor will allow deployment of a number of different sensors and feature several programming options to fit the special requirements of a given measurement site.

40070 (ANL—78-62, pp 174-189) **Overview of coal gasification for instrumentation and process control engineers.** Miller, C.L. (Dept. of Energy, Washington, DC). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

The development of a coal gasification system is the attempt to optimize the complex inter-relationships that can exist between the multiple variables associated with numerous unit operations that must be integrated into a reliable, operational system capable of converting coal into the desired/required end product. Needless to say, this effort has and will require the cooperative application of the efforts of all engineering disciplines. As demonstrated by the effort already underway in many research centers and industrial laboratories, the development of an optimum system will not be a short or easy task. Fortunately the earlier research has resulted in state-of-the-art gasification systems that can be used in the near term while the more efficient, less costly, more universal gasification systems are developed for use during the longer term. A large number of development projects are underway. These projects are generating solutions to problems encountered in all aspects of coal gasification technology.

40071 (ANL—78-62, pp 194-221) **Field test of a capacitive transducer for density/velocity (mass flow) measurement on the HYGAS Pilot Plant solvent/coal feedline.** Managan, W.W.; Eichholz, J.J.; Doering, R.W. (Argonne National Lab., IL). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

The conclusions of the field test are: the HYGAS experiment testing capacitive measurement of mass flow has shown the method to be feasible; the capacitive method provides an absolute measure of the stream velocity, neglecting the question of correction for flow profiles (that is, the method is absolute but may not be precise); the calibrated density value of capacitance versus char concentration in percent by weight is approximately linear and appears to be a useful measure of solids concentration in the slurry; auxiliary measurements of density and temperature are needed to improve the interpretation of the signals obtained from the capacitive measurement; signal-to-noise ratios obtained were sufficiently good to encourage the development of an inexpensive on-line electronic readout system; and further work is needed on the design of the density electrodes to improve the zero stability.

40072 (ANL—78-62, pp 224-260) **Valve applications at the SYNTHANE Plant in mixed phase erosive service.** Carson, S.E.; Runnels, O.D. (Lummus Co., Bruceton, PA). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

Three different control valves used for depressuring abrasive, high pressure process streams containing coal fines have been improved by upgrading their trim materials. Original trims were of ceramic or of stainless steel coated with Stellite 6. Upgraded trim materials being tested include tungsten carbide, Borofused molybdenum, and a Ceramic Coors AD 999. Additionally, several types of base material have been used for chemical vapor deposited (CVD) titanium nitride and titanium carbo nitride. An electro-deposited titanium diboride on a substrate of 410 stainless steel is also being tested. The new materials have significantly improved valve life. These valves are in operation at the SYNTHANE Pilot Plant, a high Btu coal gasification facility operated for the Department of Energy by the Lummus Company. The Plant has been in operation since July of 1976. To date, more than 2000 tons of coal have been gasified and these valves have been subjected to nearly 1000 hours operation.

40073 (ANL—78-62, pp 262-272) **Flow/no-flow indicator for the BI-GAS char feed line.** Roach, P.D. (Argonne National Lab., IL); Raptis, A.C.; Sheen, S.H.; Miller, W.R. (Argonne National Lab., IL). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

The BI-GAS coal gasification plant at Homer City, Pa. has an urgent need for monitoring char flow to the gasifier. The feed lines contain finely divided char in a steam carrier and are designed to operate at 800°F and 1500 psi. Partial or complete blockage of these lines is a recurrent problem and the plant needs a rapid and reliable method to detect such blockages. Argonne has installed a high temperature microphone in one char feed line with the goal of distinguishing between flow and no-flow conditions. This distinction will be made on the basis of the differences in signal amplitude and spectral content for the two conditions, namely flow of steam only, and flow of steam and char. So far, we have obtained data only on the background steam noise, because operational problems at the pilot plant have prevented char flow since our microphone was installed. The steam flow provides a strong microphone signal with a rich spectral content expending to about 45 kHz. Char flow data are expected to be taken in the next few months.

40074 (ANL—78-62, pp 274-301) **Instrumentation application and development on a Wellman—Galusha gasifier operating on anthracite.** Maurer, R.E.; Lonick, D. 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

An instrumentation system has been installed and is operating on a fixed bed Wellman-Galusha gasifier using anthracite. Data have been collected continuously for over 3 months. Based on these data the mass balance and conversion efficiency of the coal conversion process have been computed. The hot gas efficiency of the process under baseline operation is slightly above 90 percent. The data generated on this program will serve to establish a much needed data base for all forms of industrial coal gasification. Anthracite gasification is the simplest and cleanest gasification process. For this reason it is logical to initially establish a thorough understanding of this relatively clean coal conversion process. An additional benefit of the project will be the quantification of the process economics. The economic data derived from this program will aid industries who are considering the selection of alternate fuel systems to accurately evaluate anthracite gasification.

40075 (ANL—78-62, pp 336-353) **Calculating the effect of process measurement uncertainty in coal gasification systems.** Kirsch, L.W. (Argonne National Lab., IL). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

This paper presents a computational method for calculating the effect of process measurement error on plant performance in process control systems. The method is the stochastic modeling method (SMM) and uses computer simulation techniques. SSM was developed for the purpose of quantifying the process control instrumentation measurement accuracy and precision requirements in coal gasification systems. The basis for SMM is to model the process measurement as a stochastic process. In this case, the measurement is the sum of two values: (1) a deterministic value, which is the value an ideal instrument would measure; and (2) a random variable, which represents the measurement error. The random variable is a Gaussian variable with known mean and variance. The mean designates the expected value of the random variable, zero for a zero mean process, and the variance refers to the spread of the variable about its mean and is related to the precision of the measurement. When a system is modeled as a stochastic process the measure of how well the system satisfies its performance objectives is given by the expected or mean value of the performance criteria. The covariance gives the uncertainty in the expected performance. The simulation method is applied to a methanation reactor with outlet temperature control. The effect of increasing the uncertainty in the temperature measurement on temperature regulation is shown.

40076 (ANL—78-62, pp 366-390) **Introduction to fault tree synthesis using the Lapp—Powers methodology.** Lynch, E.P. (Argonne National Lab., IL). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

In the design of any complex system the question of reliability of equipment and instrumentation arises. A large, single train chemical plant - such as a high tonnage ammonia plant - is more economical to build and operate than a plant of the same capacity using smaller multiple trains. However, equipment or instrument failure which causes a shutdown will result in a much greater economic loss than the failure of one train of a multiple train plant. The trend is toward the high capacity single train plant but the question 'what if—' keeps coming up. There are two approaches to answering this question, both of which have been used successfully in the aerospace and electronics industries. These are Failure Modes and Effects Analysis (FMEA) and Fault Tree Analysis (FTA). It is only quite recently that these methods have been applied to the chemical industry. Both FMEA and FTA are systems approaches. To use either one it is necessary to have complete engineering flow diagrams (usually referred to as P and ID's) and complete logic diagrams. It is also necessary to define the system adequately. Although this may seem elementary it is sometimes the most difficult part of the analysis.

40077 (ANL—78-62, pp 438-475) **Process stream compositional analysis in advanced coal utilization plants using neutron-induced gamma spectrometry.** Herzenberg, C.L. (Argonne National Lab., IL); Cohn, C.E.; Cox, S.A.; Yarlagadda, B.S.; Doering, R.W.; O'Fallon, N.M.; Duffey, D. 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

Development of techniques of neutron-induced gamma spectrometry for noninvasive instrumental analysis of coal for application to process streams in coal conversion plants is described. Using ^{252}Cf sources and Ge(Li) detector based spectrometers, it appears feasible to monitor most of the elements in coal present in concentrations of 0.1 weight percent or more, including S, Fe, Si, Ca, Al, N, H, Ti, Cl, Na, and K. Correlations between gamma spectral response and element densities useful for quantitative analysis have been obtained for most of these elements. A substantially automated laboratory prototype coal analyzer based on a ^{252}Cf neutron source now continuously analyzes the gamma ray spectra from coal contained inside pipe simulating cylindrical metal cans and prints out composition information on command. Our recent work with fast neutrons from a neutron generator suggests that this source may be preferable for determination of carbon and oxygen in the coal.

40078 (ANL—78-62, pp 478-493) **Potential applications of state-of-the-art laser technology to on-stream gas analysis.** Finch, F.T.; Piltch, M.S.; Aldridge, J.P.; Flicker, H. (Los Alamos Scientific Lab., NM). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

Basically, lasers may be considered as energy probes of extremely high quality and controllability. They emit in the portion of the electromagnetic spectrum at which molecules and atoms are most sensitive to changes in their electronic, vibrational, and rotational structure. Because of this, a number of absorption and scattering techniques are available which look promising for on-line composition analysis. These techniques are not new, but frequency-tunable laser technology is only now approaching the level at which it can be utilized in such applications as on-line analysis of process gases in practical and reliable instruments. In order to realize the possibilities suggested in this paper, further development will be required. The spectroscopy of the process streams must be conducted under process conditions to determine the effects of spectral interferences by process stream constituents, the scattering of the light by particles, the background thermal radiation, and pressure broadening. Then, specific tunable lasers must be matched to specific measurement techniques, and these lasers must be engineered to meet plant instrumentation requirements of operability and reliability within an acceptable cost.

40079 (ANL—78-62, pp 542-558) **On-line gas sampling and analyzing system for a coal gasification reactor.** Fuchs, W.; Hickey, R.F.; Gibbon, G.A.; Boyce, R.E. (Pittsburgh Energy Research Center, PA). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

A gas analysis system has been installed in an experimental coal hydrogasification unit. The purpose of this system is to obtain immediate information about the composition of the feed gas and the product gas. This information is used for supervision of the process and to establish on-line material balance.

40080 (ANL—78-62, pp 692-722) **Integrated radiometric system for gasifier temperature measurements.** Zweibaum, F.M. (Barnes Engineering Co., Stamford, CT). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

An integrated radiometric system for gasifier temperature measurement has been developed, fabricated, and is now undergoing tests at the Bituminous Coat Research Bi-Gas Pilot Plant at Homer City, Pennsylvania. The purpose of this system is to monitor and to scan the radiation inside a coal gasifier reactor in order to perform several simultaneous functions. These include flame detection for alarm functions and temperature measurement by measuring radiation 2.1 micrometers in wavelength. Another function is monitoring the gasification process by scanning radiation over the range of 1.5 to 5.5 micrometers. The radiometric system monitors and scans the process by viewing it through a sighting tube. Monitoring is accomplished by two spectrally selective infrared detection systems installed in an explosion proof container and employing radiation-splitters to enable both to simultaneously view the process. One instrument continuously measures process radiation in either of two available spectral bands manually selected prior to use. Plans have been made for the installation of a second such instrument so that two-color temperature measurements can be made. The other instrument is equipped with a continuously variable filter whose spectral transmission varies with angle of rotation and which is turned by a motor drive. The paper describes laboratory tests and results. It also describes the installation at the coal gasifier reactor, the results of laboratory and field tests and some details of the next generation of instrumentation.

40081 (CONF-790405—16) **Hydrocarbonization of coal in a fluidized bed.** Youngblood, E.L.; Cochran, H.D. Jr.; Westmoreland, P.R.; Brown, C.H. Jr.; Oswald, G.E.; Miller, C.L. (Oak Ridge National Lab., TN (USA); Department of Energy, Washington, DC

(USA)). 1979. Contract W-7405-ENG-26. 28p. Dep. NTIS, PC A03/MF A01.

From AICE meeting; Houston, TX, USA (1 Apr 1979).

Hydrocarbonization is a relatively simple method of producing oil, substitute natural gas, and devolatilized char from coal. Oil and gas yields have been determined for hydrocarbonization of coal in a 0.10-m-diam fluidized-bed reactor operated at 2170 kPa and at temperatures ranging from 694 to 850 K. Subbituminous coal and bituminous coal that was pretreated with CaO, NaOH, and Na_2CO_3 to eliminate agglomeration was used. Oil yields up to 21% (based on moisture- and ash-free coal) were achieved. Data on the composition of the oil, gas, and char products are presented.

40082 (CONF-790449—1) **Monitoring and testing program of low-Btu gasifiers.** Cowser, K.E.; McGurl, G.V.; Wood, R.W. (Oak Ridge National Lab., TN (USA); Department of Energy, Washington, DC (USA)). 1979. Contract W-7405-ENG-26. 22p. Dep. NTIS, PC A02/MF A01.

From EPA fuel conversion symposium; Hollywood, FL, USA (17 Apr 1979).

Demonstration of low-Btu gasifier technology includes an extensive environmental and health study as part of the Gasifiers in Industry Program sponsored by the Department of Energy. Monitoring and testing plans have been developed to investigate the gasifiers located on the campus of the University of Minnesota-Duluth and in a planned community development at Pike County, Kentucky. Four general areas of study are emphasized in the plans including on-line studies, in-plant studies, and local area studies to be integrated through multidisciplinary assessments. A description is provided of the processes and facilities, of the rationale for the environmental and health study, and of the principal program components. Results are limited to start-up experience at the UMD gasifier.

40083 (FE—1521-70) **Development work for an advanced coal gasification system for electric power generation from coal directed toward a commercial gasification generating plant. Design report. Volume 16. Preliminary engineering design, hot flow model program.** (Foster Wheeler Corp., Livingston, NJ (USA)). 1978. Contract EX-76-C-01-1521. 292p. Dep. NTIS, PC A13/MF A01.

The design summarized in this report is sufficiently developed to allow U.S. DOE a realistic evaluation of whether this program should be continued to include the detailed engineering, procurement, construction and operation of a Process Development Unit. The design has been carried out through the "front end" phase. Various studies have been completed. Preliminary material balances have been generated and are presented. Preliminary equipment specifications and sizing and a proposed plant layout have been completed. Process and engineering flow diagrams reflect their preliminary design status.

40084 (FE—2218-22) **Improvement of the mechanical reliability of monolithic refractory linings for coal gasification process vessels. Second annual progress report July 1977—June 1978.** Anderson, E.M. (Babcock and Wilcox Co., Lynchburg, VA (USA)). Jul 1978. Contract EX-76-C-01-2218. 169p. Dep. NTIS, PC A08/MF A01.

The second annual report describes the progress made during the period July, 1977 through June, 1978 and emphasizes the eight quarter results. The report describes the status of the math model and the analyses determined with it and other stress analysis programs developed specifically for this contract. It also discusses the additional test development activities underway and reviews and discusses the results of fourteen test runs on four linings. Evidence of improved lining performance through design configuration, heating rate and material changes is presented and discussed.

40085 (FE—2240-101) **Technical evaluation for joint DOE-GRI coal gasification program. Final report.** Detman, R. (Braun (C.F.) and Co., Alhambra, CA (USA)). Nov 1978. Contract EX-76-C-01-2240. 211p. Dep. NTIS, PC A10/MF A01.

The Agreement between the United States Government and the American Gas Association for the Joint Coal Gasification Pilot Plant Research Program contained provisions for one or more technical evaluation contractors. C.F. Braun and Co. was selected as the evaluation contractor to provide an overall evaluation of the relative merits of all programs covered by the Agreement. The function of technical evaluation as described in the joint program agreement is to provide in-depth evaluations and reviews of proposed projects, proposals for research project contracts, and work under research project contracts. The evaluation contractor acts as a technical extension of the sponsoring agencies to provide information for use in making decisions on the management of the program. Assistance to be provided to contractors is defined. The contract statement defines nine categories of work. A detailed review of accomplishment in each of these areas is covered in this report. Pilot plant operation, mechanical development, design, review, evaluation, and analysis; safety assurance analysis; process studies; guideline development; conceptual process designs, factored estimates; program status presentations; and conceptual commercial designs. Braun's efforts in carrying out this contract are reviewed with summarized results of about 100 sub-tanks reported previously. (LPN)

40086 (FE—2496-38) **Review of C-MU contributions to DOE-FE's coal gasification environmental assessment program. Seventh quarterly report.** Massey, M.J. (Carnegie-Mellon Univ., Pittsburgh, PA (USA). Environmental Studies Inst.). Apr 1978. Contract EX-76-S-01-2496. 49p. Dep. NTIS, PC A03/MF A01.

In its early discussions and proposal to DOE concerning this program, C-MU stressed the critical role of process engineering analysis in the formulation of specific environmental program plans both within and across the various pilot plants. The evaluation of DOE's overall program plan, C-MU's role as program coordinator and evaluator, and its specific contract work statement all reflect a basic commitment to a strategy of process engineering analysis of scalable pilot plant environmental characteristics. In its role of providing assistance, coordination, and evaluation C-MU has performed four basic tasks: Strategic development of an effluent data base; analysis of process-related environmental engineering problems; coordination of industrial hygiene sampling and analysis efforts at the DOE pilot plants; and environmental assessment support activities. A brief but comprehensive review is given of C-MU activities and accomplishments within and across these organizations with respect to each of these four tasks. Included are references to all reports and publications generated during the course of the work.

40087 (FE—2577-T3) **Synthesis gas demonstration plant program. Quarterly technical progress report, 1 April 1978—30 June 1978.** Simpson, M.R. (Grace (W.R.) and Co., Memphis, TN (USA)). 1978. Contract EF-77-C-01-2577. 18p. Dep. NTIS, PC A02/MF A01.

Major technical activities were in the areas of development and implementation of the various trade-off study plans, conceptual design work on both the Commercial Plant and Demonstration Plant, continuation of site confirmation and environmental related activities, and assessments of licensing and permitting requirements. The final report for the Gasifier Operating Pressure Trade-off Study was delivered to DOE. Work has progressed on studies relating to gas purification alternatives, methods of coal preparation, air quality control systems alternatives, cooling tower optimization and by-product sales analyses. Data developed from these studies has been utilized in the development of plot plans, heat and material balances, process schematics, and capital cost estimates for various sections for the Commercial Plant. Demonstration Plant design activity was initiated. Activities in support of both the Site Confirmation Report and Environmental Report continued. These activities included completion of a site boring program, aerial survey, seismic refraction survey, as well as work in the areas aquatic and terrestrial ecology, land use/socio-economics, and cultural resources. Other activities during the quarter included continuation of the Design Coal investigation, preparation of a draft permits and licensing plan, and negotiations of a licensing agreement for the Texaco CoalGasification Process.

40088 (IFSM—77-87) **Fracture mechanics and surface chemistry studies of steels for coal gasification systems. First annual report, September 17, 1976—October 30, 1977.** Wei, R.P.; Simmons, G.W. (Lehigh Univ., Bethlehem, PA (USA)). 15 Dec 1977. Contract EX-76-S-01-2527. 48p. Dep. NTIS, PC A03/MF A01.

Steels used in coal gasification vessels and piping are exposed to mixtures of hydrogen, water vapor (steam), hydrogen sulfide, methane, carbon monoxide, carbon dioxide, and other gases at temperatures and pressures up to 2,000°F (~ 1370°K) and 1,500 psia (~ 10.3 Mn/m^2). Such mixtures, under certain operating conditions, can either enhance or inhibit embrittlement of these steels (that is, by the enhancement of crack growth by hydrogen and by the hydrogenous gases). The principal goal of the research under this program is to identify and establish those conditions for inhibition and for enhancement of embrittlement through a coordinated set of fracture mechanics and surface chemistry experiments on the crack growth kinetics, and on the thermodynamics and kinetics of surface reactions. The specific objective is to evaluate the thermodynamic conditions for surface film (oxides, sulfides, and carbides) formation and reduction as a potential criterion for defining safe operating conditions (gas composition, pressure and temperature) for steels that are being used or being considered for use in pressure vessels and piping for coal gasification systems. Data from this program are expected to provide fundamental information to aid in the establishment of design and operational guidelines for ensuring the safety and reliability of such systems. Progress during the first year is summarized.

40089 (M—78-68(Vol.3), pp 300-308) **Progress in the development of the desulfurizing gasifier.** Moss, G. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The development of the E.P.A. sponsored Chemically Active Fluidized Bed desulfurizing gasifier has now reached the demonstration phase and a 20 MWe unit is under construction at the La Palma plant of Central Power and Light at San Benito in Texas. Although the gasifier was originally designed for residual fuel oil, it has been established that solid fuels can also be gasified and desulfurized. The paper deals with the operation of the Abingdon pilot plant on coal and also describes what appears to be a feasible and attractive technique for the reduction of SO_2 to elemental sulfur within the regenerator of the gasifier.

40090 (METC/CR—79/15) **Chemistry of potassium and sulfur in extrained flow gasifiers.** Lewis, P.F.; Kothandaraman, G.R.; Cronin, J.F. (Physical Sciences, Inc., Wakefield, MA (USA)). Mar 1979. 40p. Dep. NTIS, PC A03/MF A01.

During this period, the thermochemistry and chemical kinetic information for potassium and potassium—sulfur species have been extended by the estimation of thermochemical properties and reaction rate constants. These values, when incorporated in the equilibrium and nonequilibrium chemistry codes, indicate no fundamental hurdle to the possibility of removal of sulfur species to levels of th order of a part per million from typical entrained flow gasifier outputs by addition of potassium to the high-temperature region of the flow followed by removal of condensed phase of potassium sulfides at the cooler downstream section. The major technical questions remaining are the condensation rates of the species and the rate of the condensed phase reaction for the formation of potassium carbonate. 9 figures, 8 tables.

40091 (METC/RI—79/5(Rev.2)) **Prototype lockhopper valve test plan.** Gardner, J.F.; Freeburn, F.D. (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center; TRW Energy Systems Group, Morgantown, WV (USA)). Mar 1979. 39p. Dep. NTIS, PC A03/MF A01.

This document has been prepared to summarize the overall plan for testing prototype lockhopper valves being developed by Fairchild Industries and Consolidated Controls Corporation under contract to DOE/FE. The testing effort described will establish the capability of these valves to meet the design criteria contained in Design Criteria for Lockhopper Valve Development, METC/SP-78/3. The design criteria was based on the requirements of the Lockhopper Valve RFP 1813, analysis of those coal conversion processes that are most promising for demonstration plants, and a desire for valve life comparable with other gasification plant equipment. The test plan was prepared with inputs from, and in cooperation with, Fossil Energy Research and Morgantown Energy Technology Center personnel and was originally published on December 30, 1976, under Fossil Energy Report FE 2213-016-09 by TRW Energy Systems Group.

40092 (MIT—2295T9-10) **Computer-aided industrial process design: the ASPEN Project. Ninth quarterly progress report, June 1—August 31, 1978.** (Massachusetts Inst. of Tech., Cambridge (USA)). 15 Sep 1978. Contract EX-76-C-01-2295-009. 122p. Dep. NTIS, PC A06/MF A01.

The major effort of this quarter has been implementation of the Basic System. Coding of all systems and subsystems except the Report Writer has started and is well under way. Parallel efforts of coding have been in progress for models and executive programs. An elementary system, consisting of a subset of the Basic System which can run the Input Translator and Simulation Program, has been planned to be tested as soon as possible. The fully integrated, tested and documented Basic System is scheduled for April 3, 1979. This data is the same as set in our original schedule over a year ago.

40093 (SAND—79-0706) **Instrumentation and process control development for in situ coal gasification. Sixteenth quarterly report: September 1978—November 1978.** Bartel, L.C. (Sandia Labs., Albuquerque, NM (USA)). Apr 1979. Contract EY-76-C-04-0789. 34p. Dep. NTIS, PC A03/MF A01.

The Hanna IV in situ coal gasification test was ignited on January 24, 1978, was interrupted in March to drill two new process wells west of Well 1, was restarted and continued until early June 1978 at which time the test was interrupted due to a high temperature override condition. The decision was made to essentially abandon the Well 1-2 side and to drill additional process and instrumentation wells on the Well-2-3 side to aid in a successful continuation of the Hanna IV test on the Well 2-3 side and insure the acquisition of useful data. Sandia Laboratories is providing instrumentation support by fielding and monitoring diagnostic and remote monitoring instrumentation technqiques. All techniques are supported by a minicomputer-based, field data acquisition system developed for this application which provides on-site, real-time reduction, analysis and display of the experimental data. During this reporting period, fielding of the additional instrumentation was completed. Restricted electrical resistivity profiles were performed at the Hanna IV site and the Gulf/TRW site to delineate subsurface geologic features and model calculations were done to aid in the interpretation. The final analysis of the pre-burn reflection seismic data shows two faults within the Hanna IV experimental area. The design for an electrical remote monitoring system to be used on Lawrence LivermoreLaboratory's Hoe Creek 3 experiment was completed.

40094 (UCRL—50026-78-4) **LLL in situ gasification project. Quarterly progress report, October—December 1978.** Will, R.Wl (ed.); Minkel, K.J. (ed.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Mar 1979. Contract W-7405-ENG-48. 41p. Dep. NTIS, PC A03/MF A01.

The work can be conveniently divided into two categories: work of a continuing nature, such as the modeling program; and work related to the next field experiment, Hoe Creek No. 3. The review of the modeling effort describes a dispersive mechanism included to transport oxygen within the gasification zone. The field results from Hoe Creek No. 3 are compared with the model results with and without dispersion. In addition, plans for including a simple gas-composition model in the two-dimensional model are discussed. Laboratory experiments with the packed-bed reactor were resumed, but a shift of emphasis toward compatibility with the field experiment was made. Use of the complete field data-acquisition system with the laboratory reactor to thoroughly debug the field system was attempted. A postburn coring program at the Hoe Creek No. 2 site was completed. The coring confirmed the burning of the Felix No. 1 seam, as well as the partial burning of the Felix No. 2. A freestanding cavity was found in the center of the burn zone. A review of the progress in design and construction of the Hoe Creek No. 3 experiment is included.

40095 (UCRL—82673) **Private sector involvement in underground coal gasification.** Stephens, D.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 May 1979. Contract W-7405-ENG-48. 8p. (CONF-790630—2). Dep. NTIS, PC A02/MF A01.

From 5. underground coal conversion symposium; Alexandria, VA, USA (18 Jun 1979).

There is considerable activity in the field of underground coal gasification: several projects are underway in addition to those sponsored by DOE. Basic Resources, Inc., a subsidiary of Texas Utilities Co., has licensed the Soviet technology and is developing underground gasification of lignites near Fairfield, Texas. The Atlantic Richfield Company has executed a successful field gasification test in a 100 ft thick subbituminous coal near Reno Junction, Wyoming. Texas A and M University is carrying out UCG tests in lignite under sponsorship of a consortium of companies. International UCG activities include a field test carried out by the Alberta Research Council near Edmonton, Alberta; further tests are planned. The Federal Republics of Germany and Belgium, with support from the Common Market, are initiating field work for underground gasification of deep (3000 ft) bituminous coal in Belgium. There has been both formal and informal cooperation between DOE and these independent projects which has been of benefit to both parties. To accelerate commercialization it is planned to conduct joint DOE/industry projects in low rank coal by teaming the in-house DOE laboratories with cost sharing industrial partners. A Program Opportunity Notice is planned to solicit the partners. Up to three field tests will be conducted in each of these joint projects, with the scale testing and industry's share of the cost increasing. The final test in each project will be a multisweep pilot operation which will represent the basis for commercial development of underground coal gasification.

40096 **Process for gas production from solid fuels.** Flesch, W.; Brachtaeuser, K.H.; Kaimann, W. (to Projektierung Chemische Verfahrenstechnik GmbH). US Patent 4,146,369. 27 Mar 1979. Priority date 7 Sep 1976, German, Federal Republic of (F.R. Germany), 8p.

A single reactor is used for gasifying solid fuels of a wide range of particle sizes without first comminuting the particles to a common size. The larger particles are gasified on a fixed bed, and the smaller ones are gasified on a fluidized bed. In the reactor, the fluidized bed is arranged above the fixed bed and gases rising from the fixed bed help to fluidize the fluidized bed. In addition, a dust gasification region can be provided above the fluidized bed.

40097 **NDE (a practical tool): reliability for full-scale plants.** *Mater. Compon. Newsl.;* No. 20, 1-8(1 Feb 1979).

Nondestructive testing methods applicable to coal gasification plant inspection are reviewed (ultrasonic testing for erosion in transfer lines, gamma radiography or thermography for refractory-lined transport lines, acoustic emission testing for refractory curing or leaks in valves, etc.). (LTN)

40098 (FE—1734-42(Vol.9)(Bk.2)) **CO_2 acceptor process gasification pilot plant. Final report, February 1971—January 1978.** (Conoco Coal Development Co., Library, PA (USA). Research Div.; South Dakota School of Mines and Technology, Rapid City (USA)). 1978. Contract EX-76-C-01-1734. 305p. Dep. NTIS, PC A14/MF A01.

40099 (FE—1734-45(Vol.12)(Bk.1)) **CO_2 Acceptor Process Gasification Pilot Plant: plant operations final report. Final report, Volume 12: Book 1 of 4, January 1972—October 1977.** (Conoco Coal Development Co., Library, PA (USA). Research Div.; Stearns-Roger, Inc., Denver, CO (USA)). 1977. Contract EX-76-C-01-1734. 149p. Dep. NTIS, PC A07/MF A01.

For the purpose of demonstrating the feasibility of the CO_2 Acceptor Gasification Process, a pilot plant was constructed at Rapid City, South Dakota, in 1971 and operated until 1977. The details of the plant design and of the operating program have been presented in previous Volumes 5 through 8. Ancillary support programs are detailed in Volumes 9 through 11. The purpose of this final report is the condensation and interpretation of the accumulated technical information to provide an adequate design basis for a larger facility. Also included is a description of the demonstrated materials of construction which are suitable to provide mechanical integrity in a commercial plant. A limited description of the pilot equipment and plant operating procedures is provided to facilitate reader understanding.

40100 (FE—2542-11) **Phase I: the pipeline gas demonstration plant. Coal fines briquetting study.** DiFulgentiz, R.A. (comp.). (Continental Oil Co., Stamford, CT (USA)). [nd]. Contract EF-77-C-01-2542. 44p. Dep. NTIS, PC A03/MF A01.

Normally fixed-bed gasifiers require a sized coal feed (ca. 2" x 1/4"), and the run-of-mine coal must be crushed and screened to yield the requisite coal feed. This coal preparation step produces a coal fines (1/4" x 0) by-product. A recent pilot plant test run has disclosed that the British Gas/Lurgi slagging gasifier can process Pittsburgh No. 8 coal containing a large percentage of coal fines without a reduction in throughput, and therefore a plant based on this process may not yield a coal fines by-product. This finding will be evaluated in more detail in the Phase III (Demonstration Plant Operations) of the project. In the interim, a preliminary design of a commercial plant has been completed based on the assumption that a sized coal feed is required for the process and that the coal fines by-product can be sold at a price equivalent to 90 percent of the cost of the run-of-mine coal. One promising alternative to selling the coal fines is to briquet them using a pitch or asphalt binder to produce a sized feedstock for the gasifier. This report evaluates this alernative. A preliminary design of a briquetting plant to handle 4,058 tons per day of coal fines has been completed. The briquetting plant is estimated to increase the erected plant cost for a commercial plant by about $7.5 million (0.8 percent). The cost of the resultant pipeline quality gas isincreased by about two percent in the most pessimistic case, and remains essentially unchanged in the most optimistic case.

LIQUEFACTION

REFER ALSO TO CITATION(S) 40055, 40056, 40062, 40063, 40064, 40065, 40068, 40069, 40081, 40092, 40114, 40125, 40174, 41111, 41228, 41373

40101 (ANL—78-62, pp 116-129) **Flow measurement of liquefied coal.** Weintraub, M.; Weiss, M.L.; Akhtar, S.; Yavorsky, P.M. (Pittsburgh Energy Research Center, PA). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

Flow measurement of the viscous, solids-laden streams characteristic of coal liquefaction products is discussed. An effective system comprised of commercially available instrumentation and technology is described. The system consists of a small vessel in which the change of liquid level is monitored by a capacitance probe and displayed on a high-speed chart. A simple mechanical differentiating scale converts the liquid level change to a flow rate. Calibration methods are described. Other types of flow meters are discussed briefly.

40102 (ANL—78-62, pp 356-363) **Man—machine interface in process control systems.** Stewart, C.R. (Honeywell, Inc., Fort Washington, PA). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

The present trend in Process Control System architecture is toward distributed control hardware and a centralized operation interface. The paper describes a distributed system and the design concepts which must be employed in such a system in order to assure that operator efficiency is maintained or increased. It includes a description of the display techniques used in designing a microprocessor based CRT console which is the functional equivalent of the traditional control panel. The paper discusses how careful attention to human factors as well as to machine characteristics leads to economic and system availability improvements and describes several applications of these techniques in a coal to liquid fuels conversion facility. This paper describes a distributed system and the concepts which must be employed in the design of an operator interface for such a system to ensure that proper advantage is taken of current technology to increase operator efficiency. In general, the principles and the implementation are based on research into the role and behavior of n operator conducted by Renzo Dallimonti of Honeywell in the early 1970's.

40103 (ANL—78-62, pp 570-583) **Overview of coal liquefaction for instrumentation and process control engineers.** Dick, G.F. (Dept. of Energy, Washington, DC). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

We believe that a major part of the development of coal liquefaction as a competitive source of liquid fuels lies in the development of reasonably priced, reliable equipment. So far, many of the small plants have resorted to exotic materials and redundancy to keep the plants on stream. There are very real incentives for improvements in the equipment and instrumentation area for equipment development in commercial plants. Even small percentage changes in equipment costs translate into substantial savings for the owners and operators of these plants. The development of reliable, cost-effective instrumentation for the monitoring and control of coal liquefaction processes will be a significant contribution toward moving the technology from the development stage to commercialization.

40104 (CONF-790213—5) **Recent developments in coal liquefaction in the United States.** McNeese, L.E.; Salmon, R.; Cochran, H.D. Jr. (Oak Ridge National Lab., TN (USA)). 26 Feb 1979. Contract W-7405-ENG-26. 38p. Dep. NTIS, PC A03/MF A01.

From 6. energy technology conference and exposition; Washington, DC, USA (26 Feb 1979).

In this paper we discuss some of the recent developments in the U.S. coal liquefaction program. The order of presentation will be first, chemistry; second, process research and development; and finally, economics and commercialization. Most recent studies seem to indicate that the cost of synthetic liquid fuels from coal in 1978 dollars will be about $25 to $35 per barrel. This, of course, can vary rather widely depending on the nature of the products and the type of financing. Another point to be considered is that inflation tends to generate a climate of uncertainty which discourages large capital investments, especially in a new industry. A synthetic fuels industry of appreciable size (say 2 million bbls/day) will probably take at least 15 years to build. And this time does not start now - it starts after economic competitiveness is achieved. Also, this is without consideration of possible regulatory or environmental restrictions that could hamper the rate of growth. The expansion of the coal mining industry to provide the necessary feedstock will also have to take place during this same time period, and will compete for investment funds. Considerations such as these tend to make us wonder whether we ought not take a more searching look at the mechanisms by which we expect the synthetic fuels industry to develop. It is not at all clear that natural marketplace forces will be able to build the industry rapidly enough to meet the demands we expect in the next 20 to 30 years. The need for governmental initiatives has been widely discussed. We wish to ephasize here the need for careful consideration of the demand-time curve for synthetic liquid fuels and of the length of time required to build an industry of the size needed.

40105 (EPRI-AF—1019) **Compilation and assessment of SRC experience: data book. Final report.** Schall, J. (Bechtel National, Inc., San Francisco, CA (USA)). Mar 1979. 321p. Dep. NTIS, PC A14/MF A01.

In this data book prepared by Bechtel National, Inc., pertinent information on the production of solvent-refined coal (SRC) and its utilization as a utility boiler fuel is compiled, reviewed, and analyzed. Detailed discussions are presented regarding the production, transportation, fuel handling, pulverization, combustion, and emission characteristics of this new fuel. The design requirements and associated capital costs to retrofit a typical existing coal-fired power plant to burn SRC are also presented. The data were gleaned from reports associated with the SRC production plants at Ft. Lewis, Washington, and Wilsonville, Alabama; pilot-scale combustion tests; and the full-scale burn tests at Georgia Power Company's Mitchell Station. This data book is intended to serve as a comprehensive information source on SRC which will be updated periodically as the technology advances.

40106 (FE—0496-T19) **Solvent refined coal (SRC) process: health programs. Research and development report No. 53: interim report No. 28, July 1, 1977—June 30, 1978. Volume III. Pilot plant development work. Part 4. Industrial hygiene, clinical, and toxicological programs.** (Pittsburg and Midway Coal Mining Co., Shawnee Mission, KS (USA)). Apr 1979. Contract EX-76-C-01-0496. 120p. Dep. NTIS, PC A06/MF A01.

The major areas of activity within the Health Programs are: an industrial hygiene monitoring program, a clinical medical exami-

nation program, an educational and personal hygiene program, and a toxicological program. Continuing industrial hygiene monitoring indicated that worker exposures during SRC II operation were generally very similar to the quite low exposures measured during the previous SRC I operation. Significantly lower levels of total suspended particulates and benezene soluble particulates were observed during SRC II operation compared to SRC I operation. The medical examination program continued to indicate the absence of discernible occupationally related changes in employee medical profiles. The employee personal hygiene and education program has continued to be generally successful. Additional visual aids have been incorporated in the educational program. The toxicology program progressed very slowly because of extraordinary difficulties at the contract toxicology laboratory. The initial toxicology subcontract was terminated in June and a revised proposal submitted to DOE to complete the SRC I toxicology and to initiate on SRC II toxicology program.

40107 (FE—2447-13) **Research guidance studies to assess gasoline from coal by methanol-to-gasoline and sasol-type Fischer—Tropsch technologies. Final report.** Schreiner, M. (Mobil Research and Development Corp., Princeton, NJ (USA)). Aug 1978. Contract EF-77-C-01-2447. 324p. Dep. NTIS, PC A14/MF A01.

This study provides a technical and economic comparison between the new Mobil methanol-to-gasoline technology under development and the commercially available Fischer—Tropsch technology for the production of motor gasoline meeting U.S. quality standards. Conceptual plant complexes, sited in Wyoming, are complete grass-roots facilities. The Lurgi dry-ash, pressure technology is used to gasify sub-bituminous strip coal. Except for the Mobil process, processes used are commercially available. Coproduction of products, namely SNG, LPG and gasoline, is practiced. Four sensitivity cases have also been developed in less detail from the two base cases. In all areas, the Mobil technology is superior to Fischer—Tropsch: process complexity, energy usage, thermal efficiency, gasoline selectivity, gasoline quality, investment and gasoline selectivity, gasoline quality, investment and gasoline cost. Principal advantages of the Mobil process are its selective yield of excellent quality gasoline with minimum ancillary processing. Fischer—Tropsch not only yields a spectrum of products, but the production of a gasoline meeting U.S. specifications is difficult and complex. This superiority results in about a 25% reduction in the gasoline cost. Sensitivity study conclusions include: (1) the conversion of methanol into gasoline over the Mobil catalyst is highly efficient, (2) if SNG is a valuable product, increased gasoline yield via the reforming of SNG is uneconomical, and (3) fluid-bed operation is somewhat superior to fixed-bed operation for the Mobil methanol conversion technology.

40108 (FE—2547-19) **Laboratory program to support H-Coal Pilot Plant operations. PDU Run 5: syncrude mode operation with catalyst addition and withdrawal.** Johanson, E.S.; Comolli, A.G. (Hydrocarbon Research, Inc., Lawrenceville, NJ (USA)). Jun 1978. Contract EF-77-C-01-2547. 93p. Dep. NTIS, PC A05/MF A01.

Run 5 was undertaken to simulate as closely as possible syncrude mode operations in the H-Coal Pilot Plant when using Illinois No. 6 coal with continuous catalyst addition and withdrawal. The process conditions were the same as those that the Pilot Plant will use for this type of operation and, in every significant respect, this PDU run met each of the targeted-specifications. The run lasted for thirty days. Operations was smooth, and there were no significant operating problems even though this was the first demonstration of the catalyst addition-withdrawal system in an actual PDU operation. One of the most significant achievements of PDU Run 5 was a demonstration of the catalyst addition-withdrawal system which was designed and built by HRI and installed as an integral component of the Process Development Unit. Its use in PDU Run 5 provided operating experience applicable to a similar system in the 600 T/D H-Coal Pilot Plant under construction at Catlettsburg, Kentucky. The distillate yields of this operation with catalyst addition and withdrawal reached catalyst steady state in ten days and essentially confirmed predictions based on previous runs in which the deactivation of a single batch of catalyst was monitored. PDU Run 5 was an important milestone in the laboratory program to support Pilot Plant operations. The catalyst addition-withdrawal system operation met all performance predictions.

40109 (FE—2547-28) **Laboratory program to support H-Coal Pilot Plant operations. Bench-Scale Catalyst Evaluation Program.** Johanson, E.S.; Comolli, A.G. (Hydrocarbon Research, Inc., Lawrenceville, NJ (USA)). Dec 1978. Contract EF-77-C-01-2547. 136p. Dep. NTIS, PC A07/MF A01.

Five bench-scale runs were made to evaluate catalysts which showed promise for improving H-Coal process efficiency. The program objectives were to evaluate two catalyst-candidates with higher density and, therefore, higher throughput capability and also two catalyst candidates with improved denitrogenation capability. Overall the program was successful in clearly demonstrating improved catalyst activity. The higher density catalyst increased the desulfurization and conversion of residual oil to lighter oil products, and reduced the viscosity of the residual oils as much as 50%. These improvements could reflect either an increase in oil yield, an increase in capacity, i.e., Pilot Plant from 600-720 tons coal per day, or in economy of design. The best denitrogenation catalysts was shown to yield a 400°F+ distillate fuel oil product which meets federal NO/sub x/ emission standards. The two best catalysts, based on overall balance improvement, were the Amocat 1A cobalt molybdate and SN4475 nickel molybdate catalysts.

40110 (K—2008) **Use of cellulose fiber filter aids as precoats in the filtration of coal liquefaction intermediates.** Conner, H.T. Jr. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). Apr 1979. Contract W-7405-ENG-26. 124p. Dep. NTIS, PC A06/MF A01.

Thesis.

A process is developed for removing the small micron-sized ash and unconverted coal material from a liquefied Emery coal. The separation is effected through constant pressure filtration using cellulose fiber filter aid as precoat. Depending upon the process and the application, the solids must be removed to avoid high sulfur concentrations in the coal-derived liquid, to minimize erosion and corrosion of equipment, and to prevent fouling and poisoning of catalysts in downstream processing, or sludge formation in storage or transportation. A fractional factorial experiment is developed for four variables and used to determine the best combination for removing the unliquefied coal and mineral matter from the liquid product. Some further tests are performed to explore the trends shown by the fractional factorial and find approximately optimum conditions for the filtration. This optimum is shown to be of interest when compared with other separation studies on an economic basis.

40111 (ORNL/TM—6681) **Coal dissolution studies: particle size distribution in coal-derived liquids as a function of degree of coal conversion.** Gilliam, T.M.; Brand, J.I.; Rodgers, B.R. (Oak Ridge National Lab., TN (USA)). May 1979. Contract W-7405-ENG-26. 67p. Dep. NTIS, PC A04/MF A01.

Exploratory studies were conducted to assess the effect of the degree of coal conversion (i.e., a decrease in the amount of pyridine insolubles) in reacted coal - athracene oil mixtures. Particle size distribution data on the reacted mixtures show that the percentage of particulates $< 10\ \mu$ in diameter increases gradually with conversion up to a conversion of about 85%. At higher conversions, the percentage of particulates $< 10\ \mu$ in diameter increases dramatically in a near-step, function-like manner. The presence of small particulates are known to be a major cause of the low-filtration rates of coal liquefaction streams. Filtration experiments on the mixtures confirm that a relationship exists between filtration rates and conversion. Thus, the results of this work bear directly on the optimal design of two-stage liquefaction processes and could lead to improved design of processes such as SRC-I.

40112 **Process for preparing a clean-burning, low sulphur liquid fuel from coal.** Solbakken, A. (to Energy Conversion Systems Ltd.). US Patent 4,145,189. 20 Mar 1979. Priority date 8 Sep 1976, United Kingdom of Great Britain and Northern Ireland (UK), 6p.

Coal is subjected to a pyrolysis process which produces an oil fraction, a char, a water fraction, and a gas by-product. The oil fraction may be desulphurized, and the ash and sulphur removed from the char by micronizing the char and using known methods to separate the carbon from the ash and sulphur. The liquid oil fraction, micronized char, and water fraction are combined and blended with or without a stabilizing agent to form a clean-burning, low sulphur liquid fuel suspension which can be transported in pipes or a bulk, and stored. A stabilizer can be applied to the blend in order to increase its stability. Common fuel oil may also be added to the resulting liquid fuel without danger of separation. When the char is micronized to less than 200 standard mesh, at least 50% by weight of the entire suspension can be the char.

40113 **Coal liquefaction process.** Karr, C. Jr. (to Energy Research and Development Administration, Washington, DC (USA); Deutsches Patentamt, Muenchen (Germany, F.R.)). German(FRG) Patent 2,700,309/A/. 14 Jul 1977. 25p. (In German).

A modification of the Synthoil process makes it possible to obtain a crude oil that can be converted into gasoline and diesel oil by conventional iol refinery processes. The process steps are described in great detail, and data of the chemical analysis are presented in the form of tables.

BY-PRODUCTS

REFER ALSO TO CITATION(S) 40162

40114 (FE—1724-33) **Utilization of coal conversion process by-products. Final report, June 28, 1974—September 27, 1977.** Solomon, I.J.; Eisenberg, W.C.; Giori, C.; Yamauchi, T. (IIT Research Inst.,

Chicago, IL (USA)). Jan 1978. Contract EX-76-C-01-1724. 168p. Dep. NTIS, PC A08/MF A01.

The work described was aimed at determining the feasibility of converting coal conversion process (CCP) by-products, i.e., chars and heavy tars, to one or more commercially useful materials. Initially oxidation of the by-products was studied. It yielded a complex mixture of organic acids. One chemical process investigated was designed to convert the oxidation mixture to terephthalic acid by means of a modified Henkel reaction. Terephthalic acid is a valuable large tonnage chemical feedstock used in many industrial processes. The product yields for the process were low, the maximum yield of terephthalic acid being 10% by weight. A preliminary economic analysis showed that the process could be economically feasible if the yields were increased. The higher benzene carboxylic acids (BCA's), benzene tetracarboxylic, benzene pentacarboxylic and benzene hexacarboxylic acids have been shown to be prime candidates to replace phosphates in detergent formulations. The feasibility of synthesizing low cost, thermosetting polymers from the carboxylic acid mixture obtained in the oxidation of the coal conversion process chars was investigated. The synthesis of polyester resins was found to offer considerable promise. This application allows the utilization of the carboxylic acid mixture as a whole with no need for separation of specific components or fractions. Polymerization reactions were conducted under conditions leading to the formation of fusible, partially polymerized resins, which were subsequently crosslinked with epoxide-functional curing agents in the presence of amine catalysts. Plastic sheets and glass reinforced composite structures were fabricated and tested.

PROPERTIES

REFER ALSO TO CITATION(S) 40189, 40203, 40208, 40224, 41366

40115 (ANL—78-62, pp 46-64) **Attenuation of ultrasonic waves in coal—water slurries.** Sheen, S.H.; Raptis, A.C.; Roach, P.D. (Argonne National Lab., IL). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

Attenuation of ultrasonic waves in coal—water slurries was investigated in the frequency range of 200 kHz to 1 MHz in coal concentrations up to 30% by weight. The coal used in this study was West Kentucky number nine coal with particle size ranging from 90 to 30 μm. Attenuation data show a linear dependence on both frequency and coal concentration in the region of investigation. Results were compared with theoretical prodictions from the equations derived by Urick and Allegra and Hawley. The experimental attenuation was found to be higher than that from the theories by an order of magnitude. The discrepancy is discussed and further investigations are suggested.

40116 (ANL—78-62, pp 422-436) **Determination of total hydrogen content of coal by nuclear techniques.** Elias, E.; Bozorgmanesh, H.; Gozani, T. (Science Applications, Inc., Palo Alto, CA). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

The hydrogen content of coal is of primary concern to both designers and operators of coal-based utility plants. The present paper reviews possible nuclear techniques for determining the total hydrogen content of coal given the wide variations in composition and density found in practical measurement. The study is based on theoretical neutron transport calculations and laboratory experiments. It is shown that hydrogen is most accurately determined by measuring the leakage of epithermal neutrons from a slab sample 30 cm thick. Using this method, hydrogen density was measured with an average absolute error of 6.2×10^{-4} g/cm^3, e.g., for 6 percent weight hydrogen and an average bulk density of 0.7 g/cm^3 the average relative error is less than 1.5 percent. This result was achieved with no prior knowledge regarding the type, composition, and bulk density of the sample. Higher accuracy is achievable if the variations in coal type are bounded. Although the present study is directed towards coal, its main conclusions can, in principle, be applied to other solid materials of variable bulk density and elemental composition.

40117 (ANL—78-62, pp 496-512) **Simple neutron—gamma spectrometers for on-stream analysis of fossil fuels.** Rhodes, J.R. (Columbia Scientific Industries, Austin, TX). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

This paper discusses the choice of instrument component for maximum reliability at minimum cost and reports the results of feasibility experiments performed using such instrumentation to determine the best nuclear rections and the sensitivities obtainable for determination of nine major and minor elements in coal. The results indicate that the following elements can be determined in measurement times of 10 mins. or less, with the precisions quoted: hydrogen, +- 0.01% H; carbon, +- 0.2% C; nitrogen, +- 0.1% N; sodium, +- 0.01% Na; aluminum, +- 0.003% Al; silicon, +- 0.05% Si; sulfur, +- 0.03% S; calcium, +- 0.1% Ca and iron, +- 0.1% Fe. Knowledge of the concentrations of these elements should enable important process parameters, such as calorific value, total ash, total sulfur, pyritic sulfur, total nitrogen and ash fusibility to be calculated in real time and so facilitate on-stream process control of fossil energy plants.

40118 (ANL—78-62, pp 514-539) **Moisture determination in coal: survey of techniques.** Brown, D.R. (Science Applications, Inc., Palo Alto, CA); Bozorgmanesh, H.; Elias, E.; Gozani, T.; Luckie, P. 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

Three electromagnetic techniques are identified as promising for eventual on-line application with coal; these are the capacitance, microwave attenuation, and nuclear magnetic resonance (NMR) techniques. Each of these techniques is examined in depth and the current extent to which they have been applied to coal is surveyed. It is found all three techniques give comparable accuracies of ~ 1% absolute. The capacitance and microwave techniques have been demonstrated with coal in the laboratory and on-line; the calibration of these techniques is sensitive to physical parameters and coal type. NMR is currently limited to small sample sizes but its calibration is much less sensitive to changes in coal type.

40119 (COO—2898-11) **Study of oxygen stoichiometry and analysis of coal, lignite, coke, and derivatives. Final report, March 1, 1976—July 31, 1978.** Volborth, A. (North Dakota State Univ., Fargo (USA)). Jul 1978. Contract EY-76-S-02-2898. 12p. Dep. NTIS, PC A02/MF A01.

Problems in the chemical analysis of coal are discussed, particularly with respect to oxygen (which has often been estimated by difference). The use of fast neutron activation analysis for determining oxygen (and perhaps also silicon and nitrogen) is discussed and recommended as the most accurate, rapid and inexpensive method. The value of such a direct determination of oxygen is emphasized: for eliminating errors involved in the determination by difference, and in studies of oxidation, humification, coalification and even moisture studies. (LTN)

40120 (FE—5065-5) **Prediction model for compositional changes within a coal from core data. Quarterly report, July—September 1977.** Renton, J.J.; Donaldson, A.C. (West Virginia Univ., Morgantown (USA). Dept. of Geology). 1977. Contract EY-76-S-05-5065. 9p. Dep. NTIS, PC A02/MF A01.

Maps and cross sections based upon analytical data from the original DD mine have been generated from individual compositional parameters and combinations of parameters which appear to have some geochemical significance (e.g., the kaolinite/kaolinite + illite ratio). Emphasis is on the computer generation of maps and cross sections and upon developing statistical procedures which will allow the comparison of map patterns as well as permit the evaluation of the potential randomness of an individual pattern. This is necessary in order to make some intelligent evaluation as to whether a pattern portrays a real geochemical control or whether the pattern demonstrates nothing but random noise and, in fact, illustrates no geochemical control at all. A regional analysis of thickness trends of the Waynesburg coal and its underlying Gilboy sandstone and overlying Waynesburg sandstone are presently being compared with equivalent attributes in the DD strip mine. The comparison reveals that the regional trends in thickness of the total coal seam as well as the coal's lower bench, middle parting, and upper bench are reflected in similar units of the strip-mine area. Regional data indicate that the strip mine is located in a thick seam area. Therefore, the strip-mine site represents an optimum environment for peat development during Waynesburg time. The regional study indicates to what extent the strip-mine area is representative of the Waynesburg coal, and in which respect it is unique.

40121 (FE—5065-6) **Prediction model for compositional changes within a coal from core data. Quarterly report, October—December 1977.** Renton, J.J.; Donaldson, A.C. (West Virginia Univ., Morgantown (USA). Dept. of Geology). 1977. Contract EY-76-S-05-5065. 14p. Dep. NTIS, PC A02/MF A01.

A group of graphs, maps, and cross sections are currently being prepared from the Waynesburg data. The data are also being computer coded for exploratory analysis. Also compositional maps are being prepared for successive six inch layers of the seam. A statistical technique has been developed which will allow the evaluation of similarity/dissimilarity of these maps. The technique uses Spearman's rank correlation as a basis and will provide two types of

information: (1) the similarity/dissimilarity between all pairs of maps, and (2) a cluster analysis grouping together maps of similar configuration. Using basic maps, a reconstruction of the paleoenvironment of the Waynesburg swamp is being developed. These maps were generated by hand, using core-log data and field data over the six quadrangles of the study area.

40122 (FE—5065-7) **Prediction model for compositional changes within a coal from core data.** Renton, J.J.; Donaldson, A.C. (West Virginia Univ., Morgantown (USA). Dept. of Geology). 1977. Contract EY-76-S-05-5065. 25p. Dep. NTIS, PC A02/MF A01.

The basic objective of the research is to devise a model based upon the three dimensional variability of the composition of a coal seam; thereby allowing the coal quality to be evaluated and predicted in any given area be it regional or local. Throughout the study investigations have been conducted into ways of evaluating the organic portion of the coal, other than the standard petrographic analysis, which would provide basic compositional data which is precise and useable without the major investment of time and operator skill required of petrographic analysis. Two such methods are: Pyrolysis-chromatography and Fourier transform of the x-ray diffraction scatter pattern. Results so far have been exceedingly encouraging indicating that pyrolysis-chromatography has the potential to be a definitive characterization technique for the compositional evaluation of coal. The data provided are perhaps not of the degree of resolution (grain on grain) afforded by petrographic analysis but has the advantages that the analysis time is short - one half hour per sample - as opposed to a considerably longer time for petrographic analysis. Perhaps even more importantly, it is almost totally instrumental and, as a result, the human imprint upon the data (human interpretations, judgements and their potential errors depending upon the degree of operator experience and competence) is kept to a minimum. It is the kind of data that lends itself to automation and computer analysis. The second technique, Fourier transform of XRD data, has also been successful. The technique can only be considered a bulk analysis but information collected to date indicates that such an analysis definitely has the potential to detect differences in the basic organic composition of coal allowing such variability to be mapped both stratigraphically and laterally.

40123 (FE—5065-8) **Prediction model for compositional changes within coal from core data. Quarterly report, April—June 1978.** Renton, J.J.; Donaldson, A.C. (West Virginia Univ., Morgantown (USA). Dept. of Geology). 1978. Contract EY-76-S-5065. 9p. Dep. NTIS, PC A02/MF A01.

Examination of 150 computer-generated compositional maps resulted in the following observations: The ash and sulfur contents of the Waynesburg coal display large variations within a distance as small as a few hundred feet. Areas of relatively high pyrite, organic and dependently total sulfur, are generally found in the western part of the mine and areas of low sulfur content are generally found in the eastern part. The distribution of sulfur within the mine shows a lateral variation which is generally consistent in shape (map pattern) throughout the thickness of both benches. The vertical distribution of sulfur shows a relative concentration at the tops of both benches. The Waynesburg coal formed during transgression over the Uniontown subdelta of the Permo-Pennsylvanian West Virginia deltaic complex. The peat began to form on the upper deltaic plain of the Gilboy river system and spread in time over the former site of the river. The coal is thinnest over the site of a near surface sandstone (Waynesburg time). Influence of differential compaction of the underlying sediments on the lower bench swamp and peat accumulation was minimal. A middle parting is everywhere present in the study area separating the coal into two benches. Rapid changes in thickness over short distances is characteristic of the parting. The upper bench is thinner and less well developed than the lower bench over much of the area. The death of the Waynesburg swamp came as waters rose flushing away the swamp and replacing it with a shallow lake. The thesis includes detailed maps of the entire stratigraphic area from which a comprehensive picture of the stratigraphic material can be constructed. A special petrographic study involved the distribution and mode of occurrence of pyrite.

40124 (FE—5065-9) **Prediction model for compositional changes within coal from core data. Quarterly report, July—September 1978.** Renton, J.J.; Donaldson, A.C. (West Virginia Univ., Morgantown (USA). Dept. of Geology). 1978. Contract EY-76-S-05-5065. 8p. Dep. NTIS, PC A02/MF A01.

The salt water marsh area at Wallop's Island, Virginia, represents restricted back barrier environment that extends almost continuously from Ocean City, Maryland to Florida. The environment is not a coal forming type swamp; it is a salt water marsh. However, it does have many of the basic geologic, geochemical, and physiologic of a peat swamp. The mechanisms of pyrite and clay mineral formation within this environment are thought to be the same as those of the coal-type swamps and offer therefore an excellent natural laboratory for the initial study. Sediment samples were collected from a variety of environments including the relatively open, marine-dominated bays, the more restricted, shallow bays (still marine dominated), the marsh surface, and the estuary channels of streams flowing off the mainland. The chemistry of the waters in all the areas was quite similar; all areas were marine dominated. The basic mineralogy of the bottom sediments was similar in all sites except in the more open bay. Most significant was the presence of pyrite. The last significant finding was that the plant materials collected contained mineral matter and that the composition of the mineral matter was the same as that of the accumulating sediment except for the presence of abundant pyrite. The plant materials were thoroughly washed of all adhering sediment so that the mineral matter observed was not that collected on the plant's surface but came from within the plant. This supports the theory that a significant portion (and perhaps a major portion) of the mineral matter is coal in not clastic in origin derived from the surrounding landmass, but rather has its origin in the plants themselves and that the concentration of ash in a coal is therefore a combination of what plant types contributed to the original peat plus the degree of chemical degradation to which the original plant materials were subjected after burial.

40125 **Determination of nitrogen and oxygen functional groups in coal-derived asphaltenes.** Schwager, I.; Yen, T.F. (Univ. of Southern California, Los Angeles). *Anal. Chem.;* **51**: No. 4, 569-571(Apr 1979).

Coal-derived asphaltenes and their derivatives, isolated from five demonstration coal liquefaction processes (PAMCO SRC, Catalytic Inc. SRC, HRI H-Coal, Synthoil, and FMC-COED) were analyzed for hydroxyl content by silylation followed by proton NMR analysis. Nonbasic pyrrolic nitrogen content was determined for these asphaltenes by elemental analysis after they were separated by solvent elution chromatography, and treated further by methylation with methyl iodide to remove residual basic asphaltenes. Nonhydroxylic ether oxygen, and basic pyridine-like nitrogen content were calculated by difference from total oxygen and nitrogen obtained from elemental analysis. Infrared absorptivity values were determined from the OH and NH absorption bands of these asphaltenes, and found to give linear correlations with the weight percentages of OH, and pyrrolic nitrogen: absorptivity/sub OH/ = 0.066 +- 0.002 wt % OH (L/g-cm); absorptivity/sub NH/ = 0.052 +- 0.006 wt % pyrrolic nitrogen (L/g-cm). 1 figure, 4 tables.

40126 **Lignin-like polymers in coals.** Hayatsu, R.; Winans, R.E.; McBeth, R.L.; Scott, R.G.; Moore, L.P.; Studier, M.H. (Argonne National Lab., IL). *Nature (London);* **278**: No. 5699, 41-43(1 Mar 1979).

Our results show that lignin-like polymers are incorporated into the macromolecules of lignite and bituminous coals. It is indicated that the polymers contain more highly cross-linked structures with increased aromaticity compared with the original lignins. This is experimentally shown by the identification of phenolic polycarboxylic acids and hydroxynaphthalene—carboxylic acids which are not found in the CuO—NaOH oxidation products of lignins and plant materials. In addition, plant polyphenols other than lignin could also be precursors for coal formation.

40127 **Hydroxyl contents of coal: new data and statistical analyses.** Yarzab, R.F.; Abdel-Baset, Z.; Given, P.H. (Pennsylvania State Univ., University Park). EX-76-C-01-2494. *Geochim. Cosmochim. Acta;* **43**: No. 3, 281-287(Mar 1979).

Data previously published for the phenolic hydroxyl content of 35 coals have been supplemented by the study of a further 17 samples. Various statistical analyses have now been made of the relationship of the data for the full set of 52 samples to other properties of the coals. Hydroxyl contents can be expressed either as fractions of total organic matter or of the total organic oxygen in the coals. Data expressed on the first of these bases exhibit a strong dependence on the degree of metamorphism of the coals, while those on the second basis do not. Statistical correlations on either basis show that systematic relations between coal properties differ for different coal provinces of the U.S.A., thus demonstrating that the properties of a coal are dependent to an important extent on the geology and geochemistry of the basin in which it is found.

40128 **Influence of temperature, geostatic, and stratal pressures on gas-permeable coals.** Ryzhenko, I.A.; Tsyrul'nikov, A.S. *Teplofiz. Teplotekh.;* No. 35, 105-108(1978). (In Russian).

Results are given for theoretical and laboratory studies of the effect that temperature, geostatic and stratal pressures have on the percolation properties of coal. The migration of methane in the fissures and macropores of the coal seams was shown to occur by way of laminar percolation or simultaneously by laminar percolation and diffusion in the gas phase, depending on conditions. 5 references.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 40054, 40058, 40215, 40223, 40225, 40226, 40227, 40228, 40229, 40230, 40231, 40258, 40259, 40260, 40261, 40262, 40263, 40264, 40268, 40269, 40270, 40271, 40272, 40273, 40274, 40804, 40805, 40808, 40809, 40810, 41375, 41447

40129 (ANL/CEN/FE—78-13) **Regeneration of sulfated limestone from FBCs and corrosive effects of sulfation accelerators in FBCs. Annual report, July 1977—September 1978.** Vogel, G.J.; Johnson, I.; Chopra, O.K. (Argonne National Lab., IL (USA)). Apr 1979. Contract W-31-109-ENG-38. 73p. Dep. NTIS, PC A04/MF A01.

The objectives of this program are to develop an economically and environmentally acceptable process for the regeneration of the partly sulfated product of a fluidized-bed coal combustor, to obtain the design data needed for the construction of larger regenerators, and to determine the possible corrosive effect on metallic alloys of sulfation acceleration agents added to the limestone sorbent. A regeneration process model has been developed; the model has been used to investigate the effects of the main variables on regenerator size and performance and to estimate the economic feasibility of regeneration. The results of an investigation of a regeneration process using a rotary kiln in place of a fluidized bed are reported. An atmospheric pressure FBC was placed into operation to study the corrosion of metallic alloys by limestone treated with various sulfation accelerators such as NaCl or $CaCl_2$. The results of corrosion studies carried out in a laboratory-scale facility are reported.

40130 (CONF-790305—8) **Removal of gaseous alkali metal compounds from hot flue gas by particulate sorbents.** Lee, S.H.D.; Johnson, I. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 25p. Dep. NTIS, PC A02/MF A01.

From ASME gas turbine closed-cycle session; San Diego, CA, USA (11 Mar 1979).

Six commercially available materials have been tested as granular sorbents to be used in granular-bed filters for the removal of gaseous alkali metal compounds from the hot (973-1153K) flue gas of pressurized fluidized-bed combustors (PFBC) for proposed combined-cycle power generation. Tests were performed using a simulated flue gas of PFBC in a laboratory-scale, fixed-bed combustor. Diatomaceous earth and activated bauxite were found to be the two most promising sorbents. The experimental results of screening tests are presented, along with the effects of temperature and superficial velocity and space velocity of the flue gas on the sorption performance for the two sorbents. Possible sorption mechanisms and applications of the sorbents are discussed.

40131 (DOE/T2549—27) **Development of potential uses for the residue from fluidized bed combustion processes. Quarterly technical progress report, December 1978—February 1979.** Minnick, L.J. (Department of Energy, Washington, DC (USA)). Apr 1979. Contract EF-77-C-01-2549. 37p. Dep. NTIS, PC A03/MF A01.

In most cases, there appears to be an optimum development of compressive strength in stabilized road base compositions when AFB residue and fly ash are proportioned on an equal weight basis in the mix. However, exceptionally high strengths are also evident with higher percentage additions of AFB residue. At this time, there is no clear indication of an optmium ratio of aggregate to total additive (AFB residue and fly ash) in these mixtures. Initial indications of the field behavior of the stabilized road base material at the experimental section in eastern Ohio show that further investigation of the expansive properties of these formulations is necessary in order to better quantify and control the rate of expansion in these compositions. Variations in operating parameters and bed compositions can have a great influence on the character of spent bed residues, as evidenced by the substantial differences noted in residue samples recently analyzed from the pilot AFB plant in Alexandria, Virginia. Initial studies confirm that low percentage additions of AFB residue to municipal sewage sludge result in significant improvements in the settling and dewatering characteristics of this sludge. Pelletized aggregate products made from AFB residue and fly ash are potentially useful in lightweight concrete applications, particularly those aggregates made from a roll pelletizer, in which theAFB residue comprises up to 80 percent by weight of the pelletized aggregate. Replacement of all or part of the fine aggregate portion in concrete masonry block mixtures by AFB residue has resulted in an apparent improvement in the masonry block product. Extended curing of AFB masonry block for periods up to one year produces increased unit weight and compressive strength of the block with no adverse volume changes.

40132 (EPA—600/7-78-058a) **Symposium on flue gas desulfurization.** Ayer, F.A. (comp.). (Research Triangle Inst., Research Triangle Park, NC (USA)). Mar 1978. 440p. (CONF-7711114—P1). NTIS.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

The proceedings document presentations made during the symposium, which dealt with the status of flue gas desulfurization technology in the United States and abroad. Subjects considered included: regenerable, non-regenerable, and advanced processes; process costs; and by-product disposal, utilization, and marketing. The purpose of the symposium was to provide developers, vendors, users, and those concerned with regulatory guidelines with a current review of progress made in applying processes for the reduction of sulfur dioxide emissions at the full- and semi-commercial scale. Eighteen papers have been entered individually into the data base. (LTM)

40133 (EPA—600/7-78-058a, pp 22-58) **Status of flue gas desulfurization systems in the United States.** Laseke, B.A.; Devitt, T.W. (PEDCo Environmental, Inc., Cincinnati, OH). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

PEDCo Environmental, under contract to the US EPA, has been monitoring the status of flue gas desulfurization (FGD) systems since 1974. The information needed for this program is obtained by visiting operational FGD systems and through periodic contacts with representatives of utility companies, FGD system suppliers, design engineering firms, and regulatory agencies. This paper summarizes the results of this program, including: (1) the current status of FGD applications in the utility sector, identifying the number of operational systems, as well as those planned or under construction as a function of system (process) type; (2) the trend in overall FGD system performance; and (3) areas of technological advancement including process design changes in the first, second, and third generation FGD systems.

40134 (EPA—600/7-78-058a, pp 59-79) **Status of SO_2 and NO/sub x/ removal systems in Japan.** Ando, J. (Chuo Univ., Tokyo, Japan). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

Major FGD installations being operated in Japan consist of 140 gypsum by-product plants with a total capacity of 18,000 MW equivalent and 25 plants (4,000 MW equivalent) by-product sulfuric acid, sulfur, and ammonium sulfate. In addition, there are abut 800 smaller plants (9,000 MW equivalent) producing sodium sulfite and sulfate. Not many FGD plants will be installed in the future, partly because ambient SO_2 concentration has almost attained the low level required by stringent regulations and partly because the by-products are now in a state of oversupply. On the other hand, many commercial NO/sub x/ removal plants have been put into operation or are under construction chiefly using selective catalytic reduction. The combination of the wet FGD and dry NO/sub x/ removal systems, however, has presented problems. Several processes for simultaneous removal of SO_2 and NO/sub x/ have been developed to avoid these problems. The paper describes some operation data of 23 major FGD plants and outlines a few new FGD and simultaneous removal processes.

40135 (EPA—600/7-78-058a, pp 80-95) **Desulfurization technology in the Federal Republic of Germany.** Holighaus, R. (KFA-PLE, Juelich, Germany). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

This paper presents an overview of the standards and regulations in effect in the Federal Republic of Germany (FRG) for SO_2 control. Also discussed from both a technical and economic point of view are the current status and plans for flue gas desulfurization systems in the FGR.

40136 (EPA—600/7-78-058a, pp 96-117) **EPRI's flue gas desulfurization program, results, and current work.** Morasky, T.M.; Dalton, S.M. (Electric Power Research Inst., Palo Alto, CA). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

EPRI has increased its efforts in evaluating, reporting, testing and developing new technologies for flue gas desulfurization. Reports that cover survey and evaluation work have been published. Results from several pilot and demonstration test programs are now in draft form and will be published shortly. We are moving into demonstration projects at Shawnee Station of TVA in lime/limestone and dual alkali, at Luenen, West Germany, in regenerable FGD subsystems, and in dry SO_2 removal at the EPRI Particulate Test Facility. New processes do not need to be developed for novelty's sake, but utilities do need economic and reliable choices that will fit their site, coal type, waste product disposal requirements,

unit size and load pattern in the 1980 to 1990 time frame. We feel EPRI can play an important part in developing and clarifying these process choices.

40137 (EPA—600/7-78-058a, pp 118-168) **Economic evaluation techniques, results, and computer modeling for flue gas desulfurization.** Torstrick, R.L.; Henson, L.J.; Tomlinson, S.V. (Tennessee Valley Authority, Muscle Shoals, AL). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

The Emission Control Development Projects group of the Tennessee Valley Authority (TVA) Office of Agricultural and Chemical Development, is involved in evaluating comparative economics of alternate SO_2 control technologies. Given within are the techniques and results of recent US Environmental Protection Agency (EPA) sponsored economic evaluations for a US Bureau of Mines-type citrate process and a generic double-alkali process utilizing updated design and economic premises. For comparison, an updated evaluation for limestone scrubbing utilizing similar design and economic premises is given. In conjunction with the EPA-sponsored Shawnee test program, Bechtel Corporation and TVA have jointly developed a computer program capable of projecting material balances and relative economics for lime and limestone scrubbing utilizing a Turbulent Contact Absorber. The current program may also be utilized to project the effect of variations in lifetime operating profile and alternative sludge disposal methods on costs for either process. The technical and economic bases for the current program are presented. In addition, future process design alternatives to be incorporated into the program and limitations of the program validity are discussed.

40138 (EPA—600/7-78-058a, pp 170-204) **Results of lime and limestone testing with forced oxidation at the EPA alkali scrubbing test facility.** Head, H.N.; Wang, S.C.; Keen, R.T. (Bechtel Corp., San Francisco, CA). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

Forced oxidation of the calcium sulfite reaction product in both lime and limestone FGD systems has been successfully demonstrated in 10 Mw prototype units at the Shawnee Test Facility. The oxidized gypsum product results in less disposal volume and settles by an order-of-magnitude faster than the unoxidized material. It filters to better than 80% solids and handles like moist soil compared with the unoxidized material which filters only to about 50 to 60% solids and is thixotropic. Three different tests are described in some detail.

40139 (EPA—600/7-78-058a, pp 205-228) **Effect of forced oxidation on limestone/SO/sub x/ scrubber performance.** Borgwardt, R.H. (US Environmental Protection Agency, Research Triangle Park, NC). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

Tests conducted at EPA's IERL/RTP pilot plant have indicated the feasibility of oxidizing calcium sulfite slurry to gypsum within the scrubbing loop of single-stage limestone scrubbers at normal operating pH. This paper reports comparative scrubber tests with and without forced oxidation to evaluate its effect on SO_2 absorption efficiency. Also of major concern in these tests was the effect of high chloride concentrations associated with the more tightly closed loop that results from the better dewatering properties of the oxidized sludge. The results of the comparisons show that the principal measures of scrubber performance (i.e., SO_2 removal, limestone utilization, and scrubberfeed supersaturation) will not be adversely affected by the oxidation process: good performance can be expected with 98% oxidation and with chloride levels to at least 20,000 ppM. Techniques of aerating the slurry in the scrubber-effluent hold tank are discussed and observations are reported regarding the effect of aeration on the limestone dissolution rate and slurry composition.

40140 (EPA—600/7-78-058a, pp 229-234) **Operating experience, Bruce Mansfield Plant flue gas desulfurization system.** Workman, K.H. Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

The Pennsylvania DER conducted stack tests and found that particulate removal for the Bruce Mansfield system is excellent. In one of the tests for sulfur dioxide, the stack emission met the State standards. In the second test the SO_2 emission was higher than the State standards of .6 lbs/million Btu input because of some problems with the lime feed system. Since better control of the scrubbing system pH has been achieved, SO_2 removal efficiency has been consistently high enough to meet the State standards. This consistency has only been achieved in the past several weeks, and whether or not it will continue to operate satisfactorily is still in question. Several major problems still exist. The air quality control system was designed to operate with a closed-loop water system, but this has never been achieved. As mentioned above, the chimney liners are still in question. Reheat burners as they are presently installed will never work properly. Mist eliminators may still be a problem, and there are many problems of a minor nature that remain to be solved.

40141 (EPA—600/7-78-058a, pp 246-254) **Scrubber experience at the Kentucky Utilities Company Green River Power Station.** Beard, J.B. Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

Operating experiences with the American Air Filter lime scrubbing flue gas desulfurization system, which consists of an adjustable throat venturi scrubber and flooded elbow for particulate removal, and a compartmented mobile bed contactor for sulfur dioxide removal, are discussed.

40142 (EPA—600/7-78-058a, pp 255-276) **Conversion of the Lawrence No. 4 FGD system.** Green, K. (Kansas Power and Light Co., Lawrence); Martin, J.R. Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

The limestone injection scrubbing system installed in 1968 on Unit No. 4 at Kansas Power and Light Lawrence Power Station was recently replaced with a sulfur oxide control system that involves use of limestone in a spray tower absorber. The rationale for changing the system, the basis for the design, and the significant design features are described. The startup and initial operation of the converted system has been satisfactorily completed. Most problems have been resolved and performance of the system meets prior predictions. Though the new system has eliminated most of the problems associated with the original Lawrence 4 AQCS, it is still a major piece of operating equipment, and therefore will require attention while operating as well as an increase in the plant's maintenance requirements. This AQCS, which uses the RS/ST (Rod Scrubber/Spray Tower) for particulate and sulfur dioxide removal, is a major improvement in flue gas desulfurization system design. The system affords essentially infinite turndown capability, few scrubber internals, and high performance capabilities.

40143 (EPA—600/7-78-058a, pp 277-291) **Status and performance of the Montana Power Company's flue gas desulfurization system.** Berube, D.T.; Grimm, C.D. Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

Sulfur dioxide and particulate removal systems on the two new 360 MW coal-fired units owned jointly by the Montana Power Company and Puget Sound Power and Light Company have successfully demonstrated performance within the Federal New Source Performance Standards. Unit No. 1 has been in operation since September 1975 and Unit No. 2 since May 1976. Three scrubber modules, each containing a variable throat venturi for particulate and sulfur dioxide removal and a spray absorption section for additional sulfur dioxide removal, serve each generating unit. No bypass capability is installed. Each 33-1/3% nominal scrubber module is capable of treating up to 40% of the flue gas flow for short periods of time. This system, which was piloted over a 2-year period, uses the alkalinity present in the Rosebud seam coal for the major portion of sulfur dioxide removal. Supplemental lime is added for pH control. The system design is based upon a maximum of 1% sulfur in the coal. The scrubber system components, design parameters, and the operational performance are discussed in the paper.

40144 (EPA—600/7-78-058a, pp 292-319) **Experience with limestone scrubbing: Sherburne County Generating Plant, Northern States Power Company.** Kruger, R.J. (Northern States Power Co., Minneapolis, MN). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

This paper discusses the physical description, operational problems, system performance, and future design considerations for the limestone wet scrubber systems at Northern States Power Company's (NSP) Sherburne County Generating Plant Units 1 and 2. The scrubber systems are designed for both sulfur dioxide and particulate removal. Units 1 and 2 went into operation in May 1976 and April 1977, respectively. Fuel for the two-unit plant is low sulfur (0.8%) western coal. The Combustion Engineering, limestone, two-stage wet scrubber systems at the Sherburne County Generating Plant were constructed after a pilot unit was tested in 1973 and 1974 at an existing NSP plant. Testing on the pilot unit resulted in numerous design changes, but did eventually confirm that these tail-

end limestone scrubber systems could remove at least 50% of the sulfur dioxide while firing coal containing 0.8%, and 99% of the particulate matter, down to an emission level equal to 0.04 grains per dry standard cubic foot. Operation of the full-size units has uncovered many problems that did not show up during the pilot testing. Many of these problems continue to hamper operation and require an extensive commitment of manpower by NSP to sustain reliable unit operation.

40145 (EPA—600/7-78-058a, pp 320-348) **Saarberg—Holter FGD process: second generation lime-based FGD system.** Esche, M. (Saarberg-Holter Umwelttechnik GmbH Saarbrucken, Germany). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

This paper describes the application of the Saarberg—Holter process in the flue gas desulfurization plant at Saarbergwerke AG's Weiher II power station. The Saarberg—Holter process is a wet lime-based scrubbing process, but with the use of certain additives, a clear scrubbing liquor is achieved and the familiar problems attached to customary first generation lime scrubbing are avoided - namely incrustation, plugging, regulation of the pH values, and sludge deposits. Thus, the Saarberg—Holter process is not simply a variation of conventional lime-based FGD systems, but a truly second-generation desulfurization process based on lime. Besides using the alkaline, clear washing liquor, which is the defining characteristic of the process, energy-saving gypsum is obtained through a fully integrated process step. The gypsum needs neither settling ponds nor chemical fixation and makes stockpiling possible. Two further installations are currently being constructed which, when operational in the chemical industry and electricity generation, will be the largest FGD plants operating on a commercial basis in Europe.

40146 (EPA—600/7-78-058a, pp 349-433) **Operational experience with three 20 MW prototype flue gas desulfurization processes at Gulf Power Company's Scholz Electric Generating Station.** Rush, R.E.; Edwards, R.A. (Southern Company Services, Inc., Birmingham, AL). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

The two 40 MW (nominal) Babcock and Wilcox pulverized coal fired boilers at the Scholz Electric Generating Station of Gulf Power Company were retrofitted with three prototype flue gas desulfurization processes. These processes are: (1) a concentrated-mode, lime-regeneration sodium/calcium dual alkali process supplied by Combustion Equipment Associates, Inc./Arthur D. Little, Inc. (2) the CHIYODA THOROUGHBRED 101 (CT-101) process, supplied by Chiyoda International Corporation, a subsidiary of Chiyoda Chemical Engineering and Construction Company, Ltd. (3) the Foster Wheeler Energy Corporation/Bergbau-Forschung GmbH dry adsorption process supplied by Foster Wheeler Energy Corporation. This paper presents a description of the systems' performance during an evaluation program conducted during 1975 and 1976. It is a summary of a complete report that is being published by the Electric Power Research Institute.

40147 (EPA—600/7-78-058b) **Symposium on flue gas desulfurization.** Ayer, F.A. (comp.). (Research Triangle Inst., Research Triangle Park, NC (USA)). Mar 1978. 614p. (CONF-7711114—P2). NTIS.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

The proceedings document presentations made during the symposium, which dealt with the status of flue gas desulfurization technology in the United States and abroad. Subjects considered included: regenerable, non-regenerable, and advanced processes; process costs; and by-product disposal, utilization, and marketing. The purpose of the symposium was to provide developers, vendors, users and those concerned with regulatory guidelines with a current review of progress made in applying processes for the reduction of sulfur dioxide emissions at the full- and semi-commercial scale. Twenty-five papers have been entered individually into the data base. (LTN)

40148 (EPA—600/7-78-058b, pp 439-452) **FGD sludge disposal: new regulatory initiatives.** Geswein, A.J. (US Environmental Protection Agency, Washington, DC). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

The possibility of FGD sludges being classified as solid wastes or as hazardous wastes (depending on the soluble impurities) is discussed. At the time this paper was written, US EPA had not proposed final regulations for the disposal of such sludges, but possible regulations are discussed based on heavy metal concentrations in leachates. (LTN)

40149 (EPA—600/7-78-058b, pp 453-495) **Economics of FGD waste disposal.** Barrier, J.W.; Faucett, H.L.; Henson, L.J. (Tennessee Valley Authority, Muscle Shoals, AL). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

Several detailed studies have been conducted by TVA's Emission Control Development Projects group to evaluate the economics of lime or limestone flue gas desulfurization (FGD). In almost all of these studies, the primary emphasis has been on the scrubber system, with less emphasis placed on the disposal of solid and liquid wastes produced by the system. This report summarizes the results of studies, both complete and underway, to evaluate the economics of four alternatives available for FGD waste disposal: (1) untreated disposal in either ponds or landfills, (2) Dravo Corporation Synearth process used in pond or landfill systems, (3) IU Conversion System Poz-O-Tec process for landfill application, and (4) Chemfix (Division of the Carborundum Company) landfill disposal process. A base case was established for the FGD system and for each disposal process. A total of 117 variations from the base cases was considered in the evaluation of the four alternatives. Total capital investment and annual revenue requirements were estimated for each case variation. Estimates were made so that the four alternatives could be compared for various plant, FGD system, and coal conditions. Two additional alternatives are currently being evaluated by TVA. These are: (1) the disposal of gypsum produced by the forced oxidation of lime or limestone FGD process sludge sulfite compounds and (2) the physical stabilization of FGD sludge by mixing and blending with dry electrostatic precipitator-collected flyash. The status of this evaluation is discussed.

40150 (EPA—600/7-78-058b, pp 496-536) **Flue gas desulfurization waste disposal field study at the Shawnee Power Station.** Leo, P.P.; Fling, R.B.; Rossoff, J. (The Aerospace Corp., El Segundo, CA). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

This paper summarizes and assesses the results obtained since the inception in 1974 of the US Environmental Protection Agency Flue Gas Desulfurization Waste Disposal Field Evaluation Project at the Tennessee Valley Authority Shawnee electric generating plant, Paducah, Kentucky. Eight disposal ponds containing lime or limestone flue gas scrubbing sludges are being monitored. The wastes, or sludges, were produced by two 10-MW equivalent prototype scrubbers: a venturi spray tower and a turbulent contact absorber. Five of the ponds contain untreated sludges, and each of the other three contains sludge that was chemically treated by one of three processors: Chemfix, Dravo, and IU Conversion Systems. Variations in the concentrations of major constituents and trace elements in the leachate, supernate, and groundwaters as a function of time are discussed for each of the ponds. Physical and engineering properties of cores taken from the chemically treated ponds are presented, and the physical and chemical characteristics of untreated sludges placed in ponds having underdrainage systems are discussed. The potential environmental impacts, safe disposal methods, and the economics for operational sites are also discussed.

40151 (EPA—600/7-78-058b, pp 537-554) **Full-scale FGD waste disposal at the Columbus and Southern Ohio Electric's Conesville Station.** Boston, D.L.; Martin, J.E. (Columbus and Southern Ohio Electric Co., OH). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

Conesville Generating Station, Columbus and Southern Ohio Electric Company, has recently been expanded by the addition of Unit No. 5, a 400-MW coal-fired boiler that burns 4.5% sulfur coal. In order to meet Ohio's New Stationary Source Performance Standard of 1.0 pounds of sulfur per million Btu, we elected to install a FGD system using thiosorbic lime that produces a sludge consisting of 30% solids composed of predominantly calcium sulfate and calcium sulfite. Various alternatives for sludge disposal were investigated, including: impoundment in a strip mine area, impoundment in a nearby valley, disposal in a new lined pond adjacent to the plant site, and disposal in the existing ash pond. All of the alternatives investigated, except for the last one, were eliminated for either environmental or economic factors. I.U. Conversion Systems (IUCS) is contracted to chemically fix the sludge to produce a stabilized material suitable for disposal. This product, known as Poz-O-Tec, will be placed in one-third of the existing ash pond. Area available is capable of storing the stabilized sludge for 20 years at a load factor of 51%. The sludge fixation process is owned by IUCS, but is operated and maintained by Columbus and Southern Ohio Electric Company personnel. This arrangement results in a minimal capital cost, but a significantly high operating cost estimated to be 1.63 mills

per kWh. This cost is expected to be reduced 0.91 mills per kWh with the operation of the No. 6 unit.

40152 (EPA—600/7-78-058b, pp 555-592) **Eighteen months of operation waste disposal system: Bruce Mansfield Power Plant, Pennsylvania Power Company.** Lobdell, L.W. (Dravo Lime Co., Pittsburgh, PA); Rothfuss, E.H. Jr.; Workman, K.H. Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

The Bruce Mansfield waste disposal system has been in operation since November 1975. The system is composed of four 1,000-HP positive displacement pumps, four slurry pipelines, and a 420-ft high earth and rock fill dam. Calcilox, a stabilizing additive, is supplied pneumatically to the slurry. Operational data regarding manpower and solutions to operational problems are presented. Pump packing life has been improved by on-the-job modifications. The system is designed to act as a closed-loop system with excess water returned to the scrubbing system. Water quality monitoring programs to meet state requirements are discussed and results presented. General maintenance requirements and operating costs are discussed.

40153 (EPA—600/7-78-058b, pp 616-648) **Potential markets for sulfur dioxide abatement products.** Bucy, J.I.; Ransom, J.M. (TVA, Muscle Shoals, AL). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

Air quality regulations require control of sulfur oxides emissions from power boilers. Recovery of sulfur in useful form would avoid waste disposal and conserve natural reserves. Marketability of byproducts is an uncertainty. Two EPA-sponsored studies were conducted by TVA to evaluate market potential for gypsum byproducts, sulfur, and sulfuric acid. A cost model was developed to estimate the least cost compliance method from three alternatives: (1) selecting a clean fuel strategy, (2) selecting a limestone throwaway scrubbing technology, or (3) selecting a sulfuric acid-, gypsum-, or sulfur-producing scrubbing technology. For plants where production of byproducts was the economic choice, a market simulation model was used to evaluate distribution of byproducts in competition with existing markets. Significant amounts of sulfuric acid could be produced from sulfur oxides in power plant flue gas and sold in competitive markets. Production and sale of byproduct gypsum have potential for control of a minor portion of the required reduction in sulfur oxides emissions.

40154 (EPA—600/7-78-058b, pp 650-664) **Status report on the Wellman—Lord/Allied Chemical flue gas desulfurization plant at Northern Indiana Public Service Company's Dean H. Mitchell Station.** Link, F.W. (Northern Indiana Public Service Co., Michigan City); Ponder, W.H. Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

The Northern Indiana Public Service Company and the US Environmental Protection Agency entered into a cost-shared contract in June of 1972 for the design, construction, and operation of a regenerable flue gas desulfurization (FGD) demonstration plant. The system selected for the project was a combination of the Wellman—Lord SO_2 Recovery Process and the Allied Chemical SO_2 Reduction Process. The FGD plant was to be retrofitted to NIPSCO's 115 MW pulverized coal-fired Unit No. 11 at the Dean H. Mitchell Station in Gary, Indiana. NIPSCO entered into contracts with Davy Powergas, Inc., for the design and construction of the FGD plant and with Allied Chemical Corporation for operation of the plant. Construction has now been completed and the FGD plant acceptance test was successfully completed on September 14, 1977. The plant is presently beginning a 1-year demonstration test period during which information will be collected and reported regarding pollution control performance, secondary effects, economics, and reliability of the system.

40155 (EPA—600/7-78-058b, pp 665-694) **Design of the 100 MW Atomics International aqueous carbonate process regenerative FGD demonstration plant.** Binns, D.R. (Atomics International Div., Canoga Park, CA); Aldrich, R.G. Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

A program is now underway to design, build, test, and operate a 100 MW second generation flue gas desulfurization (FGD) demonstration plant for the New York State electric utilities. The program is jointly sponsored by the Empire State Electric Energy Research Corporation and the US Environmental Protection Agency. The FGD process to be demonstrated is the Atomics International (AI) Aqueous Carbonate Process (ACP). Phase I of the program started on January 3, 1977, and was completed on May 20, 1977. The results are a preliminary design of the demonstration plant, a final estimate of the cost for completing the demonstration plant program (final design, procurement, construction, startup, and operation for one year), cost projections for 500 MW and 1000 MW ACP plants, and a work plan for Phase II. This paper briefly describes the ACP process and also describes the demonstration plant which will be built and operated by AI at the Huntley Generating Station of the Niagara Mohawk Power Corporation.

40156 (EPA—600/7-78-058b, pp 695-706) **Status of the catalytic oxidation (Cat-Ox) flue gas desulfurization system.** Erskine, G. (The MITRE Corp., McLean, VA); Schmitt, J.C. Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

This paper is a summary of the experience gained and problems encountered during the Cat-Ox demonstration program. The paper briefly defines the process design and outlines the construction history of Cat-Ox. However, the focus of the paper is on operating experience and problems encountered which led to the decision to discontinue the demonstration program. Brief summaries of test results and conclusions derived from the demonstration program are provided. Detailed test results from the baseline test program, acceptance testing, ESP testing, transient testing, and other special tests and studies associated with the Cat-Ox system are reported elsewhere in documentation cited by the paper. Discontinuation of the demonstration program neither proves nor disproves the feasibility of the Cat-Ox system. However, some inferences from the experiences indicate that the Cat-Ox system would probably be more desirable in an integrated system application rather than in a retrofit situation. The benefits associated with the integrated system application are: the reheat system would not be required; there could be more advantageous placement of system components and elimination of long product lines and poor accessibility of some equipment; and the annual operating costs would be lower for an integrated Cat-Ox. Since other more economical regenerable FGD systems have been demonstrated at a more advanced stage for retrofit situations, little benefit could be realized from the large expenditure to refurbish the retrofit Cat-Ox demonstration system.

40157 (EPA—600/7-78-058b, pp 707-736) **Citrate Process Demonstration Plant: a progress report.** Madenburg, R.S. (Morrison-Knudsen Co., Inc., Boise, ID); Kurey, R.A. Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

The Citrate Process Demonstration Plant represents a joint government/industry project for the commercial application of the Citrate FGD Process to an existing 60 MWe coal-fired power generation station. The Citrate Process was developed by the US Department of Interior, Bureau of Mines, and pilot tested over a three year period. Pilot testing confirmed process, operational, and performance parameters and established the design basis and engineering criteria for commercial demonstration of the Citrate Process. This paper discusses the host site, process description, the physical equipment, the operational objectives, the one year demonstration test program, the process environmental and energy impact, and the process economics.

40158 (EPA—600/7-78-058b, pp 737-751) **Philadelphia Electric's experience with magnesium oxide scrubbing.** Gille, J.A. (Philadelphia Electric Co., PA); MacKenzie, J.S. Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

The particulate and sulfur dioxide removal system at Philadelphia Electric's Eddystone Station has undergone preliminary performance testing for the past six months. Particulate removal efficiencies in the range of 97 to 98% have been demonstrated on the fly ash escaping collection in the upstream, and 93% efficient mechanical-electrostatic precipitator particulate removal system. The MgO-based regenerative SO_2 scrubbing system has been operated at SO_2 removal efficiencies exceeding 95%. Salable 98% sulfuric acid has been produced from the scrubbed SO_2 and the regenerated MgO reused in the process. A number of operating difficulties uncovered during this preliminary test period are described. The cumulative availability of 32% for the SO_2 scrubbing system with the longest continuous run being 140 hours has been disappointing. Plans for future operation of the system are discussed.

40159 (EPA—600/7-78-058b, pp 752-793) **Shell FGD process pilot plant experience at Tampa Electric.** Arneson, A.D.; Nooy, F.M.; Pohlenz, J.B. (UOP Inc., Des Plaines, IL). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

The SFGD process was developed by Shell Internationale Petroleum Maatschappij B.V. (SIPM) (The Hague, Netherlands) for

refinery applications to control SO/sub x/ emissions from oil-fired process heaters and boilers, the first commercial application is a 40-MW unit in a Japanese refinery. Preliminary experiments with flue gas from coal were carried out at the Galilestraat Station of Rotterdam GEB and gave an indication that the process could be applied to the combustion products of coal as well as fuel oil. A small-scale unit (0.6 MW) was designed, constructed, and placed into operation by UOP in 1974 at Tampa Electric Company's (TECO) Big Bend Station to determine system performance in the presence of coal-deri /ed flyash. This paper details the 2 years of operating experience with this unit. Also included are energy requirements, process economics, and a summary of the developmental status with regard to SO/sub x/ reduction, NO/sub x/ reduction, and simultaneous NO/sub x/—SO/sub x/ reduction.

40160 (EPA—600/7-78-058b, pp 794-817) **Ammonia scrubbing pilot activity at Calvert City.** Quackenbush, V.C.; Polek, J.R.; Agarwal, D. (Catalytic, Inc., Philadelphia, PA). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

A 4,000-CFM wet ammonia scrubber was operated at Air Products and Chemicals' Calvert City, Kentucky, manufacturing plant. The four-stage desulfurization unit was fed a flue gas slipstream from a 20-MW boiler firing approximately 2.3% sulfur coal. Byproducts of the open-loop system (ammonia-sulfur brine) was used as fertilizer. Emphasis throughout the program was placed on engineering optimization. Catalytic's efforts to identify and resolve problems, particularly those involving particulate emissions in the scrubbed gas, are summarized. Overall system performance, in terms of process chemistry, equipment operation, instrumentation and control, is discussed. An assessment of current status, including projected economics for a 500-MW commercial installation, is also included.

40161 (EPA—600/7-78-058b, pp 820-822) **Advanced FGD processes.** Yeager, K.E. (Electric Power Research Inst., Palo Alto, CA). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

Between now and the period 1985 to 1990, coal-fired utility generating capacity is committed to expand by 120,000 MWe. This will involve 250 units consuming 360 million tons of coal annually. This will nearly double the current utility coal-fired generating capacity. Because of the preliminary development status of alternative coal combustion and conversion technology, all of this capacity will be in the form of current pulverized coal combustion systems plus auxiliary environmental control technology. The economic impact of the 1977 Clean Air Act Amendments, depending on the outcome of judicial and political interpretation, will substantially increase the costs of these new, pulverized coal generating units. It is estimated, for example, that the average capital cost penalty for control of all pollutants will be 40% ($250 to 300/kw) of new unit costs and the operating and maintenance cost penalty will be about 100% (12 mills/Kwhr) and the heat rate penalty by 15%. On a utility industry-wide scale, these requirements convert to a capital investment of $60 billion, not including interest, $1 billion in additional operating costs annually and 50 million tons per year additional coal consumption in the 1985 to 1990 time period. Thus, cost savings to the electricity consumer through even small reductions in the cost and inefficiency of environmental control technology are in the billion dollar category. Users, suppliers and government must work together and demonstrate a best effort to minimize the technical risk and cost of flue gas desulfurization.

40162 (EPA—600/7-78-058b, pp 823-836) **Subsystem combinations for recovery processes addressing the problems.** Dalton, S.M. (Electric Power Research Inst., Palo Alto, CA). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

Hybrid process and subsystem combinations may reduce the cost of existing flue gas desulfurization processes, create more acceptable byproducts, or eliminate operating problems. Specific subsystem requirements to achieve these objectives include sodium—sulfur compound reduction, direct reduction of SO_2 to sulfur, novel absorption or contactor designs, and subsystems for retrofitting existing lime/limestone scrubbers to eliminate sludge production. Examples of subsystems with potential to respond to these requirements include the following: (1) sodium sulfate reduction (molten bath) to eliminate sodium purge for dry sorbent regeneration, and for sodium throwaway or dual alkali byproduct conversion to sulfur; (2) modified aqueous scrubbing with steam stripping to produce concentrated SO_2; (3) direct SO_2 reduction to sulfur with coal for use on SO_2 concentrating processes; (4) acid sulfate absorption for lime/limestone system retrofit to produce gypsum using limestone as feed. A summary of the (preliminary) cost potential for hybrid systems including steam stripping/direct reduction, char absorption/direct reduction, and dry injection plus molten bath regeneration is also presented.

40163 (EPA—600/7-78-058b, pp 857-883) **Options for SO_2 reduction.** Beychok, M.R.; Slack, A.V. Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

Several of the more promising recovery-type FGD processes produce a concentrated stream of SO_2 that must then be converted to sulfuric acid or sulfur, preferably the latter. This paper analyzes the various processes that can be used for reducing the SO_2, with emphasis on use of coal as the reducing agent. Experience in using coal for direct reaction with SO_2 is reviewed, as well as gasification of coal or heavy oil to give H_2, CO, or syn gas as the reductant and to give an H_2S/SO_2 mixture suitable for the Claus reaction. Finally, both dry and wet Claus processes are discussed particularly in regard to integration into an overall FGD system. Costs are given wherever meaningful data could be obtained and the comparative economics of sulfur as an FGD product are analyzed.

40164 (EPA—600/7-78-058b, pp 902-921) **Process alternatives for stack gas desulfurization with steam regeneration to produce SO_2.** Rochelle, G.T. (Univ. of Texas, Austin). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

New and existing processes are reviewed for stack gas desulfurization by aqueous scrubbing with steam regeneration to produce concentrated SO_2. H.F. Johnstone developed the basic concepts of simple absorption/stripping in the 1930s. His potential innovations to reduce steam consumption included: (1) reduced scrubber temperature, (2) the use of buffered solutions, (3) weak bases as buffers, and (4) insoluble acids as buffers. Ethylenediamine is identified in this paper as a potentially attractive weak base. Citric acid has recently been proposed as an attractive weak acid buffer. Glyoxalic acid is a unique aldehyde absorbent currently being proposed. The only commercial example of steam regeneration, the Wellman—Lord process, crystallizes Na_2SO_3 solids during stripping. This basic concept is expanded to include the crystallization of other types of solids. Methylammonium sulfite, ethylenediamine sulfite, $K_2S_2O_5$, and K_2HPO_4 are identified as solids that could be crystallized during steam regeneration. The alternatives for the buffer systems are evaluated not only in terms of steam requirements but also in terms of their effects on the ease and cost of removing sulfate impurities from the system. The numerous alternatives are structured to highlight attractive combinations.

40165 (EPA—600/7-78-058b, pp 922-933) **Application of dry sorbent injection for SO_2 and particulate removal.** Shah, N.D.; Teixeira, D.P.; Carr, R.C. (Air Quality Control, Palo Alto, CA). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

Integrated processesd designed to remove two or more pollutants simultaneously from a coal-fired boiler flue gas are of considerable interest from both an economic and operational standpoint. One such approach is through the injection of dry sorbent in the flue gas duct followed by collection of spent material and fly ash in the electrostatic precipitator or baghouse. A review of literature indicates that most of the work conducted to date is confidential and concentrated in specific areas for sales purposes without due consideration to understanding the basic parameters involved in the process. Previous investigations have confirmed that alkaline material containing calcium and magnesium are relatively ineffective in removing SO_2, while the alkaline materials containing sodium have been identified as attractive dry sorbents. A higher flue gas temperature generally results in better SO_2 removal, but basic information concerning kinetics and thermodynamics of the heterogeneous reaction is lacking. It has been concluded that a systematic study of the process under well-characterized and controlled conditions simulating practical utility boiler applications is necessary before the technology can be considered for constructing commercial installations. EPRI's current efforts in dry SO_2 removal research are focused on bench-scale research to provide a data base that will define the range of operating parameters for future pilot- and full-scale installations. The effects of sorbent type, residence time, temperature, particle size, and stoichiometric ratio on SO_2 removal efficiency and sorbent utilization will be evaluated. Future plans are described briefly.

40166 (EPA—500/7-78-058b, pp 981-995) **Technical and economic feasibility of sodium-based SO_2 scrubbing systems.** Legatski, L.K.; Makar, J.E.; Ramirez, A.A. (FMC Corp., Itasca, IL). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

Sodium-based scrubbing utilizing commercial soda ash, trona ore, and process waste liquors containing soda ash has been demonstrated to be an effective means of sulfur dioxide removal. It is especially applicable to utility boiler applications in the Eastern states where stringent state regulations require low SO_2 and particulate emission levels. A soluble salt scrubbing system offers the advantages of very high removal efficiency combined with superior entrainment removal capabilities to minimize the contribution of entrainment to particulate emissions. The Company's extensive experience with single and double-alkali sodium-based flue gas desulfurization (FGD) systems is reviewed. The operating advantages of these systems have resulted in demonstrably higher availabilities than exhibited by conventional lime/limestone systems. Comparative economics are presented and indicate that the sodium systems are competitive and can be less costly than the conventional systems for many cases. Costs per ton of coal for the various FGD alternatives indicate significant potential savings when compared to the use of low sulfur coal.

40167 (EPA—600/7-78-058b, pp 996-1015) **Sulfur recovered from SO_2 emissions at NIPSCO's Dean H. Mitchell Station.** Boyer, H.A. (Allied Chemical Corp., Morristown, NJ); Pedroso, R.I. Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

Performance tests were completed and FGD operations are being continued by Allied Chemical Corporation for Northern Indiana Public Service Co. (NIPSCO) on a regenerable FGD facility for Unit No. 11, a 115 MW boiler burning 3% sulfur coal at NIPSCO's Dean H. Mitchell Station in Gary, Indiana. This fully integrated demonstration facility successfully removes 90% of the SO_2 from the entire flue gas output of Unit No. 11 and converts the recovered SO_2 to elemental sulfur at rates over 20 tons per day. The FGD system uses the Wellman—Lord SO_2 Recovery Process of Davy Powergas Inc. and SO_2 Reduction to Sulfur Process of Allied Chemical. Jointly funded by the US Environmental Protection Agency (EPA) and NIPSCO, this fully integrated demonstration facility represents the first application of DPG's Wellman—Lord process in coal fired electric utility service and the first combination of the Wellman—Lord/Allied Chemical systems in flue gas desulfurization. It is also the first time that an experienced chemical firm has been engaged by an electric utility to manage its entire emission control facility and market the recovered products. Performance tests were successfully completed on September 14, 1977. Results were better than the performance criteria established for the acceptance test period.

40168 (EPA—600/7-78-058b, pp 1016-1021) **SO_2 spray absorption with dry wastes.** Felsvang, K.; Gude, K.; Kaplan, S. (Niro Atomizer, Inc., Columbia, MD). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

Technology which has been used within the field of industrial spray drying for more than forty years has now been adapted for solving the problems associated with flue gas desulfurization. The Niro Atomizer spray absorption system is described for SO_2 removal from boiler exhaust gases. It can further be utilized for removal of HCL or other harmful gases. The process, which is very similar to conventional spray drying technology, is outlined. It consists of the feed preparation system, which will vary depending upon the absorbant to be utilized, a transportation system for delivering the feed from the preparation site to the atomization assembly, a rotary or spinning wheel atomizer for absorbant atomization in the process chamber and a gas distribution system for obtaining the correct gas-liquid mixing within the chamber. This along with the dust collection equipment, will remove sulfur oxide and particulate pollutants prior to the flue gas emission into the atmosphere and will produce a dry residue which can be disposed of along with fly ash wastes; thereby requiring no further treatment.

40169 (FE—2579-20) **Granular bed filter development program. Phase II. Monthly technical progress report, October 1—31, 1978.** Phillips, K.E. (Combustion Power Co., Inc., Menlo Park, CA (USA)). 1978. Contract EF-77-C-01-2579. 39p. Dep. NTIS, PC A03/MF A01.

The Department of Energy is sponsoring a multiphase program to investigate the filtration potential of the moving-bed granular filter (GBF) for application in pressurized high temperature energy conversion systems. Phase I, which has been completed, included the development of a mathematical model, a cold flow parametric test series in a 1800 ACFM GBF, and investigations of potential dust plugging problems at the inlet screen. During the experimental program, collection efficiencies of 99% and filter outlet loadings less than 0.005 gr/acf were demonstrated. In addition, it was shown that controlled media spillage from the inlet screen prevented dust deposits which might otherwise impare performance. The objectives of Phase II are to investigate the effects of elevated temperature and coal combustion particulate on GBF filtration performance, to update the analytical model developed in Phase I to reflect high-temperature effects, and to demonstrate long duration GBF performance relative to corrosion, deposition, erosion, filtration efficiency, reliability, and controllability. This report includes computer model improvements and the preliminary work in preparing a 1800 ACFM fluid bed combustion facility for a parametric test program and supportive investigations of improved rear (outlet) screen configurations.

40170 (M—78-68(Vol.2), pp 821-831) **Leaching experiments on soil and mine spoil treated with fluidized bed combustion waste.** Sidle, R.C.; Stout, W.L.; Hern, J.L.; Bennett, O.L. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Columns packed with 60 cm of either acid soil or orphan mine spoil were treated with ground fluidized bed combustion waste (FBCW) to raise the pH of the upper 10 cm of soil to 4.6, 5.0, and 6.0. Columns were leached with 10 cm of water at 10-day intervals for 14 times and percolate samples were chemically analyzed. Soil columns were dissected following leachings and analyzed for total metals and macronutrients. Percolate samples collected from orphan mine spoil columns treated with FBCW showed no evidence of increased levels of B, Ca, Cd, Cd, Co, Cu, Cr, F^-, Fe, K, Mg, Mn, Na, Ni, P, Pb, SO_4/sup =/, Sr, and Zn after 14 leachings. Acid soil columns, containing a much higher level of organic matter than the mine spoil, had percolate concentrations of Ca, Mn, and SO_4/sup =/ that increased with increasing FBCW liming applications.

40171 (M—78-68(Vol.3), pp 326-345) **High-temperature high-pressure isokinetic/isothermal sampling system for pressurized fluidized bed applications.** Wang, J.C.F.; Ringwall, C.G.; Thoennes, C.M. (General Electric Co., Schenectady, NY). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

A program has been structured to characterize the efflux from a Pressurized Fluidized Bed (PFB) Reactor. Determination of particulate loading and size distribution will be accomplished along with a characterization of the vapor phase alkali metal content in the gaseous stream. A high-temperature high-pressure (HTHP) isokinetic/isothermal sampling system is developed to be used at the PFB effluent condition, namely, 1750°F and 150 psia. This HTHP system consists of a sampling nozzle, automatic isokinetic sensors and sampling controller, a five-stage cyclone train with a positive filter, a vapor condensor and a high-temperature pressure vessel to house the cyclone train. Individual components of the sampling system have been bench tested with satisfactory results. A laboratory checkout test on the assembled HTHP system is underway. Measurements using this HTHP system will be performed in an operating PFB as part of the existing United States ERDA-funded General Electric Coal-Fired Combined Cycle Development Program at the Coal Utilization Research Laboratory (CURL), Leatherhead, England in early 1978.

40172 (M—78-68(Vol.3), pp 583-605) **Mathematical model of a cross-flow moving bed granular filter.** Wigton, H.F. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

As part of an ERDA-sponsored program, the theoretical performance of a granular bed filter was modeled. The magnitudes of individual filter media grain collection coefficients for the mechanisms of impaction, interception, diffusion, and sedimentation are estimated from published theory and data. Recent work by Dr. S. Goren is used to revise these coefficients for clean media grains. The effects of captured particulate on these filter coefficients and frictional pressure drop are estimated. Governing differential equations for gas and solids flow patterns, and of media-borne and gas-borne particulate matter throughout the filter are derived. Computer solutions to these equations are used to correlate actual experimental data. The effective particle capture efficiencies of an array of packed spheres is greater than can be predicted from theories applicable to single spheres. This synergism is futher enhanced at the Reynolds numbers prevailing in the normal operational ranges of commercial filters. The effects of captured particulate material on the pressure drop and overall filter efficiency are greater than can be explained by the reduction of interstitial voids. An additional correction of media grain sphericity as it is applied in the Ergun flow correlation appears to predict these effects.

40173 (M—78-68(Vol.3), pp 640-655) **High temperature, high pressure electrostatic precipitation.** Feldman, P.; Bush, J.; Robinson, M. (Research—Cottrell, Inc., Bound Brook, NJ). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

This paper presents results of work conducted by Research-Cottrell under EPA Contract 68-02-2104. The purpose of the work completed to date was to demonstrate the ability to generate stable corona at temperatures to 2000°F and pressures to 500 psig, thus establishing the feasibility of electrostatic precipitation as a means of particulate removal from the effluent of fluidized bed combustors or coal gasifiers at high temperature and pressure. The work was quite successful in demonstrating stable corona generation and in defining ranges of temperature and pressure over which the stable discharge can be maintained. Gases investigated were air, flue gas, and simulated (noncombustible) fuel gas in coaxial wire—pipe electrodes. Pipe diameter was fixed at 3 inches; wire diameter varied from 0.062 to 0.125 inches. Results are reported for both polarities in terms of current—voltage characteristics, corona onset and sparkover voltages, and critical gas densities above which sparkover alone, without antecedent corona, occurs.

40174 Treatment of coal liquefaction effluent. Burke, F.P. (to Continental Oil Co.). US Patent 4,146,459. 27 Mar 1979. Filed date 19 Dec 1977. 6p.

A solvent extraction coal conversion process is provided wherin the effluent slurry product is subjected to vacuum distillation to yield distillate and extrudable still bottoms. The latter are removed from the vacuum still by means of an extrusion screw which is operatively associated with the still.

40175 Treatment of slimes from flotation circuit by solid bowl centrifuge. Pickering, E.P. *Mine Quarry;* 8: No. 3, 50-51, 53, 55, 58(Mar 1979).

The commissioning of the solid bowl was a most difficult exercise mainly because of the limited experience previously accumulated with this equipment. Following months of detailed investigation the following conclusions can now be drawn: (i) Coal Cliff has successfully closed its washery water circuit using solid bowl to produce a cake capable of inclusion in its refuse and a crystal-clear centrate easily returned to the washery circuit. (ii) solid-bowl operation easily lends itself to fully automatic control and thus requires no additional operating staff. (iii) The following operating parameters are important: Minimum bowl speed; reasonable solid feed-rate input control; reasonable percentage feed solid control; and in each application there will be an upper limit on the percentage of cake-to-coarse refuse that can be sustained to avoid re-slurrying the coarse refuse material.

40176 Recovering fine-size coal from Alabama surface mine washer wastes using the Humphreys spiral. Browning, J.S. University, AL; University of Alabama (1977). 17p. (NP—23726).

The Mineral Resources Institute and State Mine Experiment Station of The University of Alabama conducted Humphreys spiral tests of fine coal waste from nine preparation plants of Alabama strip mining operations, to determine the feasibility of recovering low ash, low sulfur fuel meeting steam coal specifications. The ash in the samples ranged from 9 to 51 percent, and the total sulfur ranged from 0.45 to 2.39 percent. Continuous laboratory tests using a Humphreys spiral gave good recovery of the coal with excellent rejection of the ash and pyritic sulfur. Coal recoveries of 83.6 to 94.1 percent were achieved from the different samples. Ash content of the clean coal products fell within a range of 5 to 12.2 percent, with a total sulfur content of 0.62 and 1.10 percent. In quality, the products were comparable or superior to those now being shipped from the preparation plants.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 40086, 40183, 40200, 40216, 40217, 40219, 40220, 40221, 40222, 40275, 41108, 41590, 41619, 41620, 41667

40177 (FE—2496-39) **Synopsis of C-MU technical contributions to the DOE coal gasification environmental assessment program. Second annual report for July 1977—July 1978.** Massey, M.J.; Luthy, R.G.; Pochan, M.J. (Carnegie-Mellon Univ., Pittsburgh, PA (USA)). Dec 1978. Contract EX-76-S-01-2496. 240p. Dep. NTIS, PC A11/MF A01.

The Department of Energy/Division of Fossil Energy's comprehensive field program for environmental assessment of its high- and low-Btu coal gasification pilot plant installations was initiated to develop the methodology and data base necessary for meaningful assessment of the environmental impact of the processes. Environmental characterization efforts at each pilot plant involve a detailed process engineering analysis of scalable pilot plant environmental characteristics with the goal of establishing strategy and a basis for scale-up to commerical-size installations. Carnegie-Mellon University, the program's assistance, coordination, and evaluation contractor, has performed four basic tasks: strategic development of an effluent data base; analysis of process-related environmental engineering problems; coordination of industrial hygiene sampling and analysis efforts; and environmental assessment support activities. To date, activities have encompassed work with five high-Btu pilot plants (Hygas in Chicago, Ill., Bi-Gas in Homer City, Pa., CO_2-Acceptor in Rapid City, S.D., the slagging fixed bed gasifier in Grand Forks, N.D., and Synthane in Bruceton, Pa.) and two low-Btu facilities (the Wellman-Galusha gasifier at the Glen Gery Brick Co. in York, Pa. and Combustion Engineering in Windsor, Conn.).

40178 (M—78-68(Vol.2), pp 462-476) **Development of environmental objectives based on health and ecological effects.** Cornaby, B.W.; Savitz, D.A.; Pomerantz, L.; Murthy, K.S. (Battelle Columbus Labs., OH). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Comprehensive assessments of the potential health and ecological (H/E) effects before the final design and commercialization of fluidized-bed combustion (FBC) systems are ongoing. The application of toxicological, ecological and epidemiological effects data has required synthesis of biological principles and of the published data for a variety of test organisms, routes of administration, and toxicological/carcinogenic test protocols. Initial work on setting environmental objectives for many individual chemicals has resulted in quantitative values against which FBC emission inventories are being compared. An example comparison that is provided shows lead, arsenic, and vanadium to be the elements in most need of control in bed discard from one FBC pilot plant. In addition to chemicals, nonchemical pollutant factors (noise and heat), microorganisms, and even nonpollutant factors (land usage) are being researched to develop environmental objectives. Detailed examples for noise, heat, and microorganisms are provided. The multimedia environmental goals chart is the principal tool for displaying such data. This paper puts the activities in perspective using a five-phase approach emphasizing the phases on H/E effects and evaluation. For example, a definition and examples of effects are provided, and four approaches to environmental objectives are compared.

40179 (M—78-68(Vol.2), pp 478-491) **Design of ambient monitoring programs for prototype fluidized-bed combustion facilities.** Allen, J.; Ambrose, D.; Clark, R.; Sticksel, P. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The characteristics and composition of the FBC particulate emissions differ from those of other combustion units. The trace metals and organics contained in the particulates are of special interest as they may be concentrated on the smaller respirable sizes, and also they may be more biologically accessible due to the nonfused nature of the FBC fly ash. Consequently, a special ambient sampling program is required for prototype FBC facilities. This program should gather information about the unique FBC emissions as they impact upon humans, animals, vegetation, and materials. A principal consideration is the investigation of pollutant transport between source and receptor, including the implications of variations in the characteristics of both the emissions and of the medium which the pollutants enter. Several sampling program designs for meeting these requirements are discussed.

40180 (M—78-68(Vol.2), pp 898-913) **Environmental analysis of the General Electric PFB Combined Cycle power plant design.** Lucke, V.H.; Murphy, K.R. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

An environmental assessment of the General Electric PFB Coal Fired Combined Cycle (PFB—CFCC) concept made in parallel with the Commercial Power Plant Design activity has identified atmospheric emissions and waste solids properties as being unique to the cycle. This paper interprets recent test data (Test No. 6) from the British Coal Utilization Research Agency (BCURA) facility at Leatherhead, England and the Exxon Miniplant in relation to those key environmental factors. Particular emphasis is placed upon solid wastes and the distribution of trace elements. Estimates of the future impact of this PFB—CFCC system on the environment are included.

40181 (PNL—2850(Pt.3), pp 1.41-1.43) **Studies of materials found in products and wastes from coal-conversion processes.** Petersen, M.R.; Fruchter, J.S. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

Researchers at Pacific Northwest Laboratory (PNL) have been investigating materials from synthetic fossil-fuel processes. During this past year, solids from the Lignite Gasification Pilot Plant and samples from the Solvent Refined Coal Pilot Plant (SRC-II mode) have been analyzed for organic and inorganic constituents. Observations on these samples are summarized.

40182 (PNL—2850(Pt.5), pp 2.0-2.52) **Environmental control engineering.** Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 5. Environmental assessment, control, health and safety.

Progress is reported on the following projects: assessment of environmental technology for coal gas separation; energy material transport, 1977 to 2000; dry/wet cooling towers; liquefied natural gas safety and control; burning of oil spills; liquified petroleum (LPG) research assessment; treatment of oil shale; geothermal liquid waste disposal; compressed air energy storage; energy-conserving industrial waste treatment; analysis of nuclear fuel cycles; transportation safety study; decommissioning of retired facilities at Hanford: planning; characterization of Hanford 300 Area burial grounds; decontamination and decommissioning of Hanford facilities: technology; assistance for nationwide decommissioning planning for DOE nuclear facilities; and, asphalt emulsion sealing of uranium tailings. (JGB)

RESERVES AND EXPLORATION

REFER ALSO TO CITATION(S) 40120, 40121, 40122, 40123, 40124, 40128, 40185, 40210

40183 (RLO—2229/T15-5) **Comprehensive bibliography and index of environmental information for the Beluga—Susitna, Nenana, and western arctic coal fields.** Buck, E.H.; Allen, A.; Olshansky, R.B.; Pennell, S.H. (Alaska Univ., Anchorage (USA). Arctic Environmental Information and Data Center). Jan 1979. Contract EY-76-S-06-2229-015. 132p. Dep. NTIS, PC A07/MF A01.

This bibliography and index was compiled to provide increased access to environmental information pertinent to three major coal areas in Alaska. Often information necessary for adequate decision-making on large projects is scattered throughout many documents. This bibliography and index compiles pertinent information and facilities access to many publications. It includes: Section I, a master bibliography which contains a complete bibliographic citation for each document; Section II, an alphabetical author index; Section III, a geographic index and a keyword location index; Section IV, a map index and a biological (taxonomic) index; and Section VII, a general keyword index. (LTN)

MINING

40184 (DOE/MC/08089—T1) **Methane recovery from coalbeds. Integrating contractor, annual report, CY 1978.** (TRW, Inc., McLean, VA (USA). Energy Systems Planning Div.). 1978. Contract EW-78-C-21-8089. 29p. Dep. NTIS, PC A03/MF A01.

Work done in the engineering and integration effort in the Morgantown Energy Technology Center program to recover and utilize methane from coalbeds is summarized. The contract requirements and approach are outlined. The work accomplished includes the development of the Unminable Drilling Plan, performance of testing and data analysis for wells into coal seams, development of three conceptual recovery and utilization designs. Future work planned is outlined. Milestone and expenditure charts are provided. (JSR)

40185 (EPRI-EA—674) **Computer software to calculate and map geologic parameters required in estimating coal production costs. Final report.** Honea, R.B.; Petrich, C.H.; Wilson, D.L.; Dillard, C.A.; Durfee, R.C.; Faber, J.A. (Oak Ridge National Lab., TN (USA)). Apr 1979. Contract W-7405-ENG-26. 124p. Dep. NTIS, PC A06/MF A01.

This report documents methodologic and computer software developed by Energy Division and Computer Sciences Division personnel at Oak Ridge National Laboratory (ORNL). The software is designed to quantify and automatically map geologic and other cost-related parameters as required to estimate coal mining costs. The software complements the detailed coal production cost models for both underground and surface mines which have been developed for the Electric Power Research Institute (EPRI) by NUS, Corp. These models require input variables such as coal seam thickness, coal seam depth, surface slope, etc., to estimate mining costs. This report provides a general overview of the software and methodology developed by ORNL to calculate some of these parameters along with sample map output which indicates the geographical distribution of these geologic characteristics. A detailed user guide for implementing the software has been prepared and is included in the appendixes. (Sample input data which may be used to verify the operation of the software are available from ORNL.) Also included is a brief review of coal production, coal recovery, and coal resource calculation studies. This system will be useful to utilities and coal mine operators alike in estimating costs through comprehensive assessment before mining takes place.

40186 (PB—287086) **User's manual for premining planning of eastern surface coal mining. Volume I. Executive summary. Final report, June 1975—July 1978.** Ramani, R.V.; Clar, M.L. (Pennsylvania State Univ., University Park (USA). Dept. of Mineral Engineering). Aug 1978. 82p. NTIS PC A05/MF A01.

Recommended methods, techniques, and alternatives for selecting and designing mining systems, based on a review and critical evaluation of the methods reported in the literature and applied in the field, and using the geological and hydrological settings prior to mining as basic inputs, have been structured into guidelines for developing, evaluating, and selecting mining and reclamation plans, prior to commencement of mining.

40187 **5th OSU applied mechanisms conference.** Stillwater, OK; Oklahoma State University (1977). 503p. (CONF-771166—).

From 5. OSU applied mechanisms conference; Oklahoma City, OK, USA (6 Nov 1977).

The 5th OSU applied mechanisms conference was held November 6—9, 1977 at Lincoln Plaza, Oklahoma City, Oklahoma. One paper from the proceedings dealing with the development of equipment for hydraulic mining was entered into EDB and ERA. (LTN)

40188 **Hydrominer spray arm drive system design.** Barker, C.R. (Univ. of Missouri, Rolla). pp 32.1-32.14 of 5th OSU applied mechanisms conference. Stillwater, OK; Oklahoma State University (1977).

From 5. OSU applied mechanisms conference; Oklahoma City, OK, USA (6 Nov 1977).

The drive system described provided the proper motion of the vertical spray arms and satisfied the criteria of the water jets intersecting at the ends of the arm travel. The operation of the mechanism was very satisfactory at crank speeds below 200 rpm. Above 200 rpm, excessive deflections of the high pressure tubing used as the spray arms did occur. The drive system was a simple and reliable solution to provide the required arm motion. The ruggedness of the linkage was limited by the available space in which to install the components. In the new design considerations, the drive mechanism will be designed first and then the head framework located around the linkage. This will permit achieving the proper strength of the components to be compatible with the environment present in a coal mine.

TRANSPORT AND HANDLING

REFER ALSO TO CITATION(S) 40175, 40211, 40212, 40213, 41114

40189 (ANL—78-62, pp 650-667) **Continuous extrusion of coal: a progress report on coal pump development.** England, C.; Kushida, R.; Daksla, C.; Feinstein, S.P. (Jet Propulsion Lab., Pasadena, CA). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

Experimental work has centered on modified thermoplastic extruders, utilizing a single screw design, in which bituminous coals enter as a granular solid and exit as a viscous fluid at elevated pressure. Analysis of computer modelling of extruders supports the experimental work and is designed to aid scaling to commercial sizes. This paper presents a progress report of experiments and analysis related to the extrusion of Kentucky No. 9, a high volatile B bituminous coal. This coal was selected only on the basis of easy availability, and does not represent a particularly favorable or unfavorable coal for extrusion. Measurements of the viscosity of coal in its plastic state are being made to aid in both the analytical effort and in the design of screws and dies specifically tailored for coal. The basic equipment and technique for the experiments is from the thermoplastics processing industry.

40190 (IS-M—169) **Modification of the floatability of coal pyrites.** Wheelock, T.D.; Ho, T.K. (Ames Lab., IA (USA)). 1979. Contract W-7405-ENG-82. 11p. (CONF-790219—7). Dep. NTIS, PC A02/MF A01.

From AIME annual meeting; New Orleans, LA, USA (18 Feb 1979).

The effect of various flotation depressants and surface treatments on the floatability of coal derived pyrites in the presence of MIBC was investigated with a modified Hallimond tube microflotation cell. The floatability of pyrite particles which had been cleaned with hot dilute (5%) hydrochloric acid was relatively large. However, the floatability of such particles was reduced greatly by the addition of specific depressants such as calcium hydroxide and also by treating the pyrite with an aerated warm alkaline solution. Although this treatment and these depressants also had some effect

on the floatability of coal particles, the effect was much less than on the pyrite particles.

40191 (ORNL/TM—5953) **Survey and evaluation of current and potential coal beneficiation processes.** Singh, S.P.N.; Peterson, G.R. (Oak Ridge National Lab., TN (USA)). Mar 1979. Contract W-7405-ENG-26. 310p. Dep. NTIS, PC A14/MF A01.

Coal beneficiation is a generic term used for processes that prepare run-of-mine coal for specific end uses. It is also referred to as coal preparation or coal cleaning and is a means of reducing the sulfur and the ash contents of coal. Information is presented regarding current and potential coal beneficiation processes. Several of the processes reviewed, though not yet commercial, are at various stages of experimental development. Process descriptions are provided for these processes commensurate with the extent of information and time available to perform the evaluation of these processes. Conceptual process designs, preliminary cost estimates, and economic evaluations are provided for the more advanced (from a process development hierarchy viewpoint) processes based on production levels of 1500 and 15,000 tons/day (maf) of cleaned product coal. Economic evaluations of the coal preparation plants are conducted for several project financing schemes and at 12 and 15% annual after-tax rates of return on equity capital. A 9% annual interest rate is used on the debt fraction of the plant capital. Cleaned product coal prices are determined using the discounted cash flow procedure. The study is intended to provide information on publicly known coal beneficiation processes and to indicate the relative costs of various coal beneficiation processes. Because of severe timeconstraints, several potential coal beneficiation processes are not evaluated in great detail. It is recommended that an additional study be conducted to complement this study and to more fully appreciate the potentially significant role of coal beneficiation in the clean burning of coal.

40192 (PB—287369) **Role of transportation of energy in the development of the southwest.** Anderson, O.L.; Rogozen, M.B. (Lake Powell Research Project, Los Angeles, CA (USA); California Univ., Los Angeles (USA). Inst. of Geophysics and Planetary Physics). Aug 1977. 47p. NTIS PC A03/MF A01.

The total cost of an energy transportation project consists of hard costs which are directly measurable in traditional ways, and soft costs which reflect social impacts, political conflict, environmental damage, and other less readily quantifiable impacts. Soft costs and benefits are playing an increasingly important role in decision making for western energy projects. General models for estimating the hard costs of unit train and coal slurry pipeline transportation of coal were developed and run. It was found that soft costs such as the political difficulty of obtaining water for slurry pipelines may outweigh the hard costs.

40193 (UT/CES-PI—5) **Economic comparison between the coal slurry pipeline proposed by Houston Natural Gas Corporation and two comparable unit train models.** Hyde, T.E. (Texas Univ., Austin (USA). Center for Energy Studies). Jan 1979. 201p. Dep. NTIS, PC A10/MF A01.

In order to estimate the initial capital requirements and annual expenses for these three models, an Office of Technology Assessment study is used that measures the costs of unit train operations and coal slurry pipelines in general. The costs that result from this estimation are then compiled over a thirty year period employing discount rates from 1 to 20 percent. For real required rates of return below 12 percent, the slurry line is less expensive than either rail system. In fact, a cost saving of $250 million is realized by the pipeline if an average real required rate of 5 percent is assumed for the life of the projects. This resolution, however, has several qualifications that must be taken into account. To begin with, slurry pipelines are not the best alternative in every case. Many factors may exist that make such a transport system uneconomical and/or unfeasible. Also, to insure fair competition between railroads and this slurry line, both should be allowed to engage in long-term contracts. Finally, a source of water large enough to adequately supply the pipeline and all other dependents must be found before any construction begins so that no conflicts of interest will erupt.

40194 **Method of removing gangue materials from coal.** Keller, L.J. (to Keller Corp.). US Patent 4,146,366. 27 Mar 1979. Filed date 21 Nov 1977. 14p.

A method of removing gangue materials from coal characterized by the steps of comminuting and sizing all of the material to have most particles of a size smaller than one hundred microns; slurrying in an alcohol containing 1 to 4 carbon atoms; thereafter separating by settling velocity separation into an overflow stream containing most of the valuable coal products for storage as a fuel or the like and an underflow containing the gangue materials with some larger sized coal particles; thereafter diluting the underflow with alcohol and separating by settling velocity separation or the like into an overflow stream containing the coal for storage and an underflow containing mostly gangue material with some coal particles; separating the alcohol from the gangue materials and returning the alcohol to the process. The gangue materials can be employed as a fuel if they contain enough of the entrained coal particles. Preferably, the comminution to effect mostly particles smaller than 100 microns is effected by a multi-step process including crushing and screening to drying size; drying; and separating into top and bottom streams, the hot latter being sent to a thermal-chemical reactor employing cool alcohol and thermal shock to effect partial comminution; and further comminution to effect the particle sizes less than 100 microns. Also disclosed are specific details of the process to effect a low cost nonpolluting carbonaceous fuel, feed stock, or hydrocarbon fuel extender.

COMBUSTION

REFER ALSO TO CITATION(S) 40058, 40129, 40170, 40171, 40172, 40173, 40178, 40179, 40180, 40780, 40781, 40782, 40796, 40797, 40798, 40799, 40800, 40801, 40811, 40812, 41458, 41459, 41460, 41461, 41462, 41463, 41464, 41465, 41466, 41467, 41469, 41470

40195 (ANL—78-62, pp 418) **Effects of unmixedness on gas temperature measurements in practical combustors.** Dils, R.R. (National Bureau of Standards, Washington, DC). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

The gases within practical combustors display a number of special features which obtain from the design and operation of the combustor. Primarily, the gases are only partially mixed, and this unmixedness results in large gas temperature and velocity fluctuations throughout the combustor. The unmixedness affects combustor performance, pollutant formation, and the durability of downstream components. The unmixedness can also introduce significant errors in the accuracy of time average measurements within the combustors. In this paper, gas temperature oscillations from 200°F to 2800°F are documented within several combustors, and gas temperature oscillations from 400°F to 2000°F are demonstrated in the combustor exhausts. The exhaust gas velocity fluctuations are on the order of 10% of the mean velocity. The combustion processes nonlinearly amplify acoustic and flow disturbances within a 0 to 1000 hz bandwidth and, as a result, the majority of the power in the gas temperature and velocity waves are contained within this bandwidth. The general dependence of time average quantities measured with nonlinear devices on the degree of unmixedness of a complex gas stream is developed and then applied using the experimental data to compute the errors in time average temperatures measured with large thermocouples and optical and calorimeter devices.

40196 (ANL—78-62, pp 628-648) **Gas and solids sampling systems for B and W/EPRI's 6x6 Fluidized Bed Hot Test Facility.** Bonk, D.L.; Elmer, C.M. (Babcock and Wilcox Co., Alliance, OH). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

The Babcock and Wilcox Company, under contract to the Electric Power Research Institute, has designed a 6'x6' (1.8m x 1.8m) Atmospheric Pressure Fluidized Bed Combustion (AFBC) Hot Test Facility. Tests performed on this facility are intended to improve the understanding of carbon utilization (combustion efficiency) in a fluidized bed boiler. The flexible design of the facility permits physical changes to the unit as well as variations in operating parameters that can directly affect carbon utilization. To quantify the effects of these physical changes and operating variables on the combustion efficiency of the 6'x6' AFBC facility, or any similar boiler system, specialized gas and solids sampling probes are required. This paper reviews the probe designs used during initial testing on the 6'x6' AFBC, the operating problems encountered, and some of the preliminary data obtained.

40197 (ANL—78-62, pp 670-680) **Control of atmospheric pressure fluidized bed combustion steam generator systems.** Berkowitz, D.A. (Mitre Corp., Bedford, MA). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

The approach we have applied to control system development for nonlinear, thermofluid processes, such as atmospheric pressure fluidized bed combustion (FBC) steam generator systems, is a 3-step procedure involving: development of a nonlinear, dynamic model for process analysis and simulation; validation of the model with steady state design data, steady state experimental data, or transient response measurements, whatever is available; and application of the model to analytical controller design. The approach has been successfully applied to conventional fossil fueled power plants. It has been applied subsequently to atmospheric pressure FBC systems, including the Process Development Unit (PDU) at Alexan-

dria, Virginia, and the Component Test and Integration Unit being acquired by the Morgantown Energy Technology Center. As an existing and operational experimental facility, the PDU afforded an opportunity to apply the modeling methodology to FBC systems, and to carry out model development and experimental validation steps. Additional electrical output process transmitters and a flexible Data Acquisition System were installed in order to measure transient response. The model was found to be a valid representation of the process, suitable for describing its dynamic performance and designing controllers.

40198 (ANL—78-62, pp 776-785) **Operation and control of the Exxon pressurized fluidized bed coal combustion pilot plant.** Nutkis, M.S. (Exxon Research and Engineering Co., Linden, NJ). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

The Exxon Research pressurized fluidized bed coal combustion pilot plant, known as the miniplant, has been in operation since 1974. Constructed under EPA contract, this facility operates at pressures to 10 atm, bed velocities to 10 ft/sec and temperatures to 1800°F. It can burn 400 lb of coal/hour and has operated for over 2000 test hours. Instrumentation, control techniques and experience have been developed and refined in the various aspects of PFBC. Details regarding temperature sensing and control, coal feeding, thermowell materials experience, and solids sampling and collection are discussed.

40199 (ANL—78-62, pp 788-804) **Control and process instrumentation for the 6' x 6' fluidized bed boiler test facility.** Apa, R.P. (Babcock and Wilcox Co., Alliance, OH); Bonk, D.L.; Lund, T.E. 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

The initial philosophy employed during design and construction phases of the 6' x 6' fluidized bed boiler by The Babcock and Wilcox Company under a research contract with the Electric Power Research Institute was to select controls and process instrumentation which were commercially available, yet simple. By adhering to this philosophy, the problem of obtaining replacement parts is minimal and the setting of instrument response to process variation is relatively easy. A second principle adopted was that all process controls should be independent of the data acquisition system. This division was to be maintained since the computer system software was designed primarily to obtain and reduce data for determining combustion efficiency and heat transfer coefficients, rather than for process control. This paper describes the success and failure in following the philosophy of using simple, yet commercial, instrumentation and controls. The problems encountered with the control and process instrumentation are discussed as are the modifications which were made after gaining operational experience. The effectiveness of the safety interlocks and their impact upon unit operations are also considered. The ability of this unit to provide research data and to successfully operate as a small boiler providing steam for heating B and W's Alliance Research Center is shown.

40200 (CONF-790338—1) **Pollutant emissions from "dirty" low- and medium-Btu gases.** Waibel, R.T.; Fleming, E.S.; Larson, D.H. (Institute of Gas Technology, Chicago, IL (USA)). 1979. 41p. Inst. of Gas Technology, Chicago, IL.

From 3. EPA stationary source combustion symposium; San Francisco, CA, USA (5 Mar 1979).

Data were collected to determine the emissions from "dirty" low- and medium-Btu gases when combusted on industrial process burners. The fuels utilized were blended to have the composition typically found for Wellman-Galusha oxygen (WGO) and air (WGA) fuel gases. Baseline data were collected for natural gas, ambient WGO and WGA, and hot WGO (700K) and WGA (616K). Then ammonia, hydrogen sulfide, coal tar and char were added singly at various levels and in combinations to the hot fuels in a parametric study to determine the effects of these contaminants on pollutants emissions. The burners used in this study were a forward-flow baffle burner and a gas momentum controlled kiln burner. These burners were mounted in turn on a pilot-scale test furnace equipped with water tubes as a load and were each fired at 1.03 +- 0.07 MW(t) (3.50 +- 0.25 X 10^6 Btu/h) with 10% excess air and 477 K (400°F) air preheat. The following conclusions were made: low-Btu fuels not subjected to post-gasifier cleanup can yield NO/sub x/ levels greatly above the thermal levels for the clean fuels and for natural gas. In turbulent diffusion flames, fuel-NO/sub x/ increases with an increase in a) the amount of fuel-nitrogen, b) the amount of fuel sulfur, c) the level of excess air, and d) the degree of initial fuel/air mixing. Attempts to close the fuel-sulfur balance were unsuccessful. Compared tonatural gas, heat transfer to the load is reeduced for the low-Btu fuels tested. This heat transfer is not greatly affected by the presence of contaminants (tar and char) at levels characteristic of raw gasifier effluents. 8 figures, 16 tables.

40201 (FE—2489-33) **Development of combustion data to utilize low-Btu gases as industrial process fuels. Project 61004 special report No. 4: high-forward-momentum burner.** Waibel, R.T.; Fleming, E.S. (Institute of Gas Technology, Chicago, IL (USA)). Nov 1978. Contract EX-76-C-01-2489. 42p. Dep. NTIS, PC A03/MF A01.

Data were gathered to determine the performance of a high-forward-momentum burner when retrofit with three low-to-medium-Btu gases. The burner was fired on the IGT pilot-scale test furnace with a load simulating one zone of a continuous refractory kiln or one instant during the heat-up of a batch kiln. The low- and medium-Btu gases simulated for these combustion trials were Koppers—Totzek oxygen, Wellman—Galusha air, and Winkler air fuel gases. All of the substitute fuels exhibited stable flames when directly retrofit on the burner. Koppers—Totzek oxygen gave a thermal efficiency slightly greater than that for natural gas, but Wellman—Galusha and Winkler air fuel gases each had lower efficiencies. Koppers—Totzek oxygen and Wellman—Galusha air fuel gases had flame lengths longer than that for natural gas, whereas Winkler air fuel gas had a flame length comparable to the natural gas flame.

40202 (FE—2489-43) **Development of combustion data to utilize low-Btu gases as industrial process fuels. Project 61004 quarterly status report, October 1—December 31, 1978.** Waibel, R.T.; Fleming, E.S. (Institute of Gas Technology, Chicago, IL (USA)). May 1979. Contract EX-76-C-01-2489. 6p. Dep. NTIS, PC A02/MF A01.

Tests for all eight burners have been completed. The fifth special report (flat-flame burner) has been approved for publication, the sixth special report (high-excess-air burner) has been submitted to the DOE project officer for approval, the seventh report (premix-tunnel burner) is being typed, and the eighth special report (boiler burner) is being written.

40203 (FE—3128-T1) **Studies for the stabilization of coal—oil slurries (COM). Technical progress report, August—November 1978.** Botsaris, G.D.; Glazman, Y.M.; Naar, R.Z.; Viola, M.A. (Tufts Univ., Medford, MA (USA). Dept. of Chemical Engineering). 29 Nov 1978. Contract ET-78-S-01-3128. 30p. Dep. NTIS, PC A03/MF A01.

The following tasks were undertaken: a) equipment for measuring viscosities, grinding and classifying coal powders, grinding COM, and blending rubber and coal were obtained, and coal samples covering the whole spectrum of ranks as well as oils for the whole investigation were procured; b) coal surface characterization by the so-called "Bound Rubber Test" and heats of immersion were investigated; c) the development of tests for COM stability characterization according to a model was initiated.

40204 (M—78-68(Vol.2)) **Proceedings of the fifth international conference on fluidized bed combustion. Volume II. Near-term implementation.** (Mitre Corp., McLean, VA (USA). METREK Div.). Dec 1978. Contract EX-76-C-01-2453. 962p. (CONF-771272—P2). Dep. NTIS, PC A99/MF A01.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The papers are grouped into several major headings: overview of commercialization activities, industrial applications, utility applications - atmospheric, utility applications - pressurized, and environmental aspects. Fifty-three papers have been entered individually into EDB and ERA. (LTN)

40205 (M—78-68(Vol.2), pp 14-19) **Practical and commercial application of fluid bed combustion for use in industrial boiler plants.** Caplin, P.B. (Energy Equipment Co., Ltd., Olney, Buckinghamshire, England). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The purpose of this paper is to examine some methods for applying fluid bed combustion to boiler plant, by the use of resilient, stable combustion units with the facility of complete automatic control. Some of the advantages that we can expect to obtain by use of the fluid bed are listed.

40206 (M—78-68(Vol.2), pp 22-39) **Industrial coal fired fluidized bed boilers and waste heat boilers.** Virr, M.J. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

A fluidized-bed waste heat boiler was designed to put on the back end of a 12,000 hp Sulzer diesel engine running on heavy fuel oil in a 40,000 ton tanker. Design considerations are described. In particular, cleaning gear consisting of a stainless steel brush for clearing the incoloy distributor is mentioned. Operating experience has been satisfactory. (LTN)

40207 (M—78-68(Vol.2), pp 117-144) **Comparison of conventional oil-fired and fluidized bed coal-fired petroleum refinery atmospheric**

crude furnaces. Bliss, C. (MITRE Corp., METREK Div., McLean, VA). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

A significant consumption of liquid petroleum fuels and natural gas occurs in the operation of direct-fired industrial tubular furnaces, particularly in the petroleum refining industry. The functions served by much of this equipment could also be served by the redesign of the equipment for firing with coal in the fluidized-bed combustion mode. But, at the same time, a number of factors need to be addressed in order to avoid practical operating problems. This paper compares the designs of conventional furnace equipment and fluidized-bed coal fired equipment that is envisaged as offering equivalent performance. Operating practices for the conventional unit are described, and design features that should enable practical operation of the fluidized bed fired units in an equivalent manner to the conventional units are presented and discussed. The design of an atmospheric stage crude oil heating furnace that has been reported in the literature is selected to illustrate the comparison.

40208 (M—78-68(Vol.2), pp 145-155) **Fluidized bed hot gas generator for conversion of oil-fired boilers into coal-firing.** Basu, P.; Das, K.L.; Chanda, M.K. (Central Mechanical Engineering Research Inst., Durgapur, India). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Fluidized bed combustion is highly suitable for Indian coal which is rich in ash. A packaged fluidized bed burner is being developed to convert oil-fired systems into coal-firing. Design and initial test results of a converted boiler is discussed. A review of fluidized bed development in India is also presented.

40209 (M—78-68(Vol.2), pp 160-167) **Department of Energy atmospheric fluidized bed combustion utility demonstration program.** Trexler, E.C. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The evolving National Energy Act of 1977 calls for the conversion of existing gas and oil-fired electric utility plants to coal by 1990 and for the use of coal-fired generators in new plant construction. Combined with the increasingly stringent environmental constraints and economic considerations, the Congress has presented the electric utilities with a formidable challenge. The fluidized bed combustion boiler is a strong contender for meeting this challenge. This paper describes the energy goals in more detail and describes the Department of Energy (DOE) Atmospheric Fluidized Bed Combustion (AFBC) Utility Demonstration Program which is being pursued to assist the private sector in meeting this challenge.

40210 (M—78-68(Vol.2), pp 169-185) **Technological development priorities of atmospheric fluidized-bed combustion.** Mesko, J.E. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Successful initial operation of the world's first multicell atmospheric fluidized-bed boiler (MAFB) at the Monongahela Power Company's Rivesville, W.Va. plant helped to advance the technology closer to commercial reality. It is realized, however, that additional technological development tasks and near-term priorities must be set to identify the most critical areas, where further research, development and demonstration work is required. The Rivesville MAFB operation identified some of the new areas of concern, which, up till now, due to size limitations of other fluidized-bed units in operation had not been demonstrated. The paper presents an overview of the technological development areas that must be addressed if atmospheric type fluidized-bed steam generators are to become a commercial reality.

40211 (M—78-68(Vol.2), pp 203-221) **Startup and initial operation of the Rivesville 30 MWe fluid bed boiler.** Stringfellow, T.E.; Branam, J.G. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

This paper discusses the start-up, testing, and initial operation of the multicell fluidized-bed boiler at Rivesville, West Virginia -- the only industrial size fluidized bed boiler operational in the United States. It comprises four sections: a brief history of fluidized-bed boilers; equipment check out, initial running and initial pre-operational tests such as air flow calibration; a summary of the MFB operating history, including problems encountered and solutions attempted; and conclusions derived from the experience gained at Rivesville which will be helpful to future designers and operators of fluid bed boilers.

40212 (M—78-68(Vol.2), pp 239-246) **Material handling systems for FBC's: extrapolating Rivesville to 600 megawatts.** Murphy, J.J. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

In this paper, a suggestion is made on how the Rivesville systems, with their problems and solutions, can be adapted to a 600 megawatt unit at the very high temperatures that are generated in a fluid bed combustor. The metallurgy of the materials handling valves and transport system is unique, and the technology used at Rivesville in this respect, could become an important factor in the future power generation in the United States.

40213 (M—78-68(Vol.2), pp 248-265) **Investigation of alternative feed systems for utility-scale fluidized-bed steam generators/combustors (200MWe or larger units).** Biswas, B.K.; Baley, J.U. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

A review and analysis were made of the requirements for large, utility-scale fluidized-bed steam generators and combustors. Based on an evaluation of available equipment, the investigators concluded that the multipoint-feed principle is highly impractical. As a viable alternative, the spreader—stoker feed system can be adapted to throw coal and limestone above the fluidized bed. This is a proven system, developed over the past 55 years. Although there may be some concern about the spreader—stroker method of throwing fines into the furnace, analysis of the potential problems shows that most of them can be easily solved.

40214 (M—78-68(Vol.2), pp 375-384) **Experiences of fluidized-bed combustion of peat in Finland.** Jahkola, A. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Fluidized-bed combustion of peat has been studied by the Laboratory of Energy Economics and Power Plants in the Helsinki University of Technology since 1975. The final goal of the study will be to develop a peat-fuelled district heating power plant. Within the study a series of laboratory tests has been carried out using an atmospheric FBC with diameter of 0.6 m. As an intermediate application a hot water FBC-boiler for district heating has been planned and built in Kajaani town. This boiler has an atmospheric FBC with diameter of 3 m and a thermal output of 4 MW. Since its completion in April 1977 the boiler has been in commercial operation except for the summer months. It has worked satisfactorily. This boiler might be the first commercial energy producing FBC-plant in the world. In the paper—experiences of FBC of peat in the above mentioned 0.6 m and 3 m combustors are discussed. It can be noticed that peat is in many respects a different fuel from e.g. coal and that the FBC-technology offers an attractive solution to combustion of peat.

40215 (M—78-68(Vol.2), pp 493-521) **Plans and studies on flue gas cleaning and particulate monitoring in PFBC.** Swift, W.M.; Lee, S.H.D.; Montagna, J.C.; Smith, G.W.; Johnson, I.; Vogel, G.J.; Jonke, A.A. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

In pressurized fluidized-bed combustion (PFBC), emissions of particulates and alkali metal compounds in the flue gas from the combustor will contribute to the erosion and corrosion of hardware. A program to characterize, monitor, and control both particulate and alkali metal emissions from pressurized, fluidized-bed combustors is under way. Information has been obtained on the following: (1) two light-scattering, particle-size analyzers which have been tested in the flue gas of the combustion system, (2) granular-bed filtration experiments using spent, sulfated limestone as the material in a fixed-bed collector, and (3) characterization of the emissions of sodium and potassium compounds as gaseous and paniculate, fixation of the sodium and potassium in the combustion residue through the use of additives in the fluidized bed, and removal of the alkali metal compounds from the combustion gases in a high-temperature getter trap.

40216 (M—78-68(Vol.2), pp 526-542) **Thermodynamic projections of trace element release in fluidized-bed combustion systems.** Alvin, M.A.; O'Neill, E.P.; Keairns, D.L. (Westinghouse R and D Center, Pittsburgh, PA). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The chemical fate of minor and trace elements is important in assessing the environmental impact of the fluidized-bed combustion process and in determining the operating conditions that lead to corrosion-inducing deposits on metal surfaces. Thermodynamic calculations of the equilibrium product distribution for sixteen elements

of concern have been carried out, for operating conditions corresponding to atmospheric and pressurized fluidized-bed combustion systems. The results show which elements are likely to be volatilized in the high-temperature zone of the combustor and which are likely to condense again on cooling the gases. More detailed calculations have been performed for the alkali metals, showing how much alkali is released, the potential effect of additives injected to reduce alkali emissions, and the likely composition of the deposits on turbine hardware. The projections are compared with available experimental data. Although the fluid-bed combustor does not operate at chemical equilibrium, and thermodynamic data for many important species and phases are not available, thermodynamic projections are useful in focusing experimental studies on specific issues in considering the ultimate disposition of any element in the feedstock.

40217 (M—78-68(Vol.2), pp 544-558) **Multimedia pollutant emissions data for fluidized-bed combustion of coal.** Murthy, K.S.; Allen, J.M.; Sharp, D.A.; Duke, K.M. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Fluidized-bed combustion of coal generates air emissions, solid residue, and, indirectly, liquid wastes (primarily as solid residue leachate). Hence FBC can impact on all three media. The potential impact of these emissions on health and environment is being investigated by the US EPA through its Environmental Assessment Program. The first step in this investigation is to measure the concentrations of known and potential pollutants in the FBC effluents via a comprehensive analysis of emissions. In April 1977, a comprehensive analysis was completed on emissions from a pressurized fluidized-bed (the Exxon miniplant). The results of this analysis are presented here. Parallel comprehensive analyses of emissions from atmospheric-pressure units have not been conducted on a similar scale, but are planned for 1978. However, emissions data available from other analyses of several atmospheric-pressure units have been discussed recently by Henschel.

40218 (M—78-68(Vol.2), pp 560-575) **Effluent characterization from a conical pressurized fluid bed.** Priem, R.J.; Rollbuhler, R.J.; Patch, R.W. (National Aeronautics and Space Administration, Cleveland, OH). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

A major unknown in the use of a pressurized coal burning fluidized bed (PFB) providing gases for driving a gas turbine is the turbine blade lifetime due to corrosion and erosion. Studies on erosion and/or corrosion rates in gas turbines have been conducted at the NNASA—Lewis Research Center. However, very little data are available to predict erosion and corrosion rates produced by the effluent from a PFB. To assess the potential of alloys developed for aeronautical applications to resist this environment, it was decided in 1975 to build a coal burning fluidized bed that could be used to measure erosion and corrosion rates. To obtain useable corrosion and erosion results it was considered necessary to have data with several levels of particulate matter in the hot gases. One level of particulate loading would have to be as low as possible, so that ideally no erosion and only corrosion would occur. For this reason a conical fluidized bed was used to obtain some degree of filtration through the top of the bed which would not be highly fluidized. This would minimize the filtration required for the hot gases or conversely the amount of particulate matter in the hot gases after a given level of filtration by cyclones and/or filters. This paper descries the data obtained in the first 138 hours of testing. It represents 31 different tests over a range of bed heights, coal flows, air flows,limestone flows, and pressure. The testing involved a series of tests over a range of operating conditions to characterize the reactor effluents and efficiency of operation. All variations were made keeping in mind that ultimate operation of the bed had to be suitable for long duration turbine blade material testing.

40219 (M—78-68(Vol.2), pp 577-592) **NO reduction by char in fluidized combustion.** Beer, J.M.; Sarofim, A.F.; Chan, L.K.; Sprouse, A.M. (Massachusetts Inst. of Tech., Cambridge). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

It has been shown from pilot plant and laboratory scale experiments that nitric oxide, which is formed in high concentrations near the distributor plate is partially reduced through reaction by char, higher in the fluidized bed. Experimental studies giving information on the NO—char reaction, were carried out using a laboratory scale fixed bed and fluidized bed reactor. Results of the fixed bed studies enabled material balances to be closed on nitrogen and oxygen. It was shown that the products of the NO—char reaction are CO, CO_2, and N_2. The effect of external diffusion upon the overall rate of the reaction was found to be negligible for particles of 50-200 μm size. The conversion of NO in the fixed bed varied from 90 percent at 650°C bed temperature to 3 percent at 399°C for 50 μm size particles; it was also strongly dependent on particle size; an increase from 10 percent to 24 percent conversion was obtained when the particle size was changed from 200 μm to 40 μm, at an operating temperature of 550°C. In the laboratory size fluidized bed the NO conversion due to char ranged from zero at 600°C to 100 percent above 825°C. The conversion increased linearly with the weight percent char in the bed over the range of 0.25 to 2.5 percent. Initial kinetic evaluation of the reaction rates obtained in the fixed bed and fluidized bed reactor is presented and potentialapplications of the results to industrial designs of fluidized bed combustors are discussed.

40220 (M—78-68(Vol.2), pp 594-603) **Control of nitric oxide and carbon monoxide emissions in fluidized bed combustion.** Sakamoto, K. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Nitric oxide emissions from fluidized bed combustion systems must be controlled to be less than that of conventional pulverized coal firing systems, which have already attained a low level by the development of low nitric oxide emission burners. A 3.4 square feet bench scale fluidized bed combustion test equipment has been used to evaluate the effects of operating variables such as sorbent particle diameter, fluidizing gas velocity, and primary air ratio in two stage combustion and gas recirculation ratio on nitric oxide and carbon monoxide emissions. It was confirmed that nitric oxide emissions could be controlled to meet the above requirement by resonable two stage combustion. In conclusion, we have confirmed the following three items in regard to control nitric oxide emissions. Firstly, gas recirculation through the distributor plate has resulted in only a slight decrease of nitric oxide emissions. Secondly, two stage combustion has a great effect on the decrease of nitric oxide emissions, and in this way it is predicted the target emission level can be reached. Thirdly, the baffle plate above the fluidized bed and the utilization of a revolving type air distributor are both effective in decreasing carbon monoxide emission in two stage combustion.

40221 (M—78-68(Vol.2), pp 605-624) **Model study for the development of low NO/sub x/ fluidized-bed coal combustors.** Horio, M.; Mori, S.; Muchi, I. (Nagoya Univ., Japan). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

A mathematical model of fluidized-bed coal combustion is derived in order to estimate the performance of a fluidized-bed combustor under fuel-rich conditions as well as oxygen-rich cases. The major factors considered in the formulation are the size distribution of coal fed to the bed, ash off-take, elutriation of fines, the following three reactions: i) $C + 0.5\ 0_2 = CO$, ii) $CO + 0.5\ 0_2 = CO_2$, iii) $CO_2 + C = 2CO$ and the reduction of nitric oxide by char. By calculating the concentration profiles of gaseous species along the bed axis, the model is compared with the experimental data of Gibbs et al.. Fairly good agreement was obtained between the model and the observed data. Parametric studies are performed to test the effects of perturbations in operating conditions. It is found that the size distribution of coal particles affects the NO concentration significantly. Process configurations of two-stage fluidized-bed combustion are studied by the model searching the basic concept of a low NO/sub x/ FBC system.

40222 (M—78-68(Vol.2), pp 680-699) **Initial assessment of alternative SO_2 sorbents for fluidized-bed combustion power plants.** Newby, R.A.; Keairns, D.L. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Alternative metal oxide SO_2 sorbents for regenerative fluidized-bed combustion (FBC) power plants (AFBC and PFBC) have been screened on the basis of thermodynamic projections of desulfurization and regeneration performance. Estimates of sorbent availability and regeneration process economics are utilized to project maximum tolerable rates of sorbent loss by deactivation, attrition, preparation wastage, and so on. Critical performance requirements and development needs are presented. Alternative sorbents having the greatest potential are identified. The results indicate that there is very little economic incentive to develop alternative sorbents for pressurized fluidized-bed combustion if the basis of comparison is the pressurized calcium-based once-through performance. On the other hand, the economic incentive to develop alternative sorbents is highest for the pressurized systems if the basis of comparison is the pressurized calcium-based regeneration performance. The incentive to develop alternative sorbents for the atmospheric-pressure system is lower than for the pressurized system and is very low for some of the sorbents.

40223 (M—78-68(Vol.2), pp 701-727) **Regenerative iron bearing sorbents for use in fluidized bed combustion.** McGauley, P.J.; Dor, A.A.; Bunge, F.H. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

This paper discusses the use of iron bearing sorbents in large fluidized-bed steam generating plants. It also discusses sorbent regeneration and low cost production of elemental sulfur at large power generating plants that consume fuels high in content of sulfur. Laboratory and semi-pilot plant data and preliminary economic studies have indicated that, in comparison with limestone desulfurization, the above combined process could significantly reduce the cost of both sorbent feed materials and spent sorbent disposal. Additional studies also indicate that this application would enable savings in the fuel feed system, and permit additional flexibility in the design and operation of fluidized-bed steam generators.

40224 (M—78-68(Vol.2), pp 729-743) **Effects of coal composition and ash reinjection on sulfur retention burning lignite and western subbituminous coals.** Goblirsch, G.M.; Fehr, R.W.; Sondreal, E.A. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The ash of North Dakota lignites and many other Western coals contains high percentages of the alkali constituents of calcium, magnesium, and sodium which are available to react with the sulfur liberated from the coal during combustion. When burned in conventional pc-fired furnaces, these fuels retain from 10 to 40 percent of the coal sulfur in the ash. Based on a statistical study, the percentage of coal sulfur retained by the inherent alkali during pc firing is principally dependent on sulfur capture by the sodium and calcium oxides present, but is also influenced by the aluminum oxide and silicon oxide concentrations. The aluminum and silica appear to react with the alkali and yield it unreactive for sulfur capture. These same coals when burned in a FBC should retain a greater percentage of sulfur on the ash because: 1) the increased contact time between the sulfur dioxide produced during the combustion process and the inherent ash alkali allows reaction between coal ash alkali, oxygen, and SO_2 to be carried further towards completion; and 2) the lower temperatures at which the fluidized combustion process takes place are below the dissociation temperature of the alkali sulfates, and below the ash fusion temperatures so that the alkali is not tied up with the glassy agglomerate. Tests in the 6-inch AFBC have been performed on one North Dakota lignite from the Beulah mine, over arange of operating conditions with and without reinjection of the ash collected by the primary cyclone. Tests on nine additional lignites and Western coals were performed to evaluate the effects of coal and ash composition on sulfur retention. The data so far indicate that the most important factor affecting the sulfur retention by these coals is the alkali-to-sulfur ratio.

40225 (M—78-68(Vol.2), pp. 748-761) **Prediction of limestone requirements for SO_2 emission control in atmospheric pressure fluidized-bed combustion.** Snyder, R.B.; Wilson, W.I.; Johnson, I. (Argonne National Lab., IL). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The limestone—SO_2 reactivity as determined on a thermogravimetric analyzer was used to estimate the quantity of limestone required to meet the SO_2 emission standard in atmospheric fluidized-bed coal combustors. Comparison of laboratory TGA calcium utilization with pilot plant experimental results were made. Estimates of SO_2 retention in a carbon burnup cell were made for various limestone feed options. The quantities of limestone required for AFBC—CBC plants to meet SO_2 emission standards have been estimated. Four different limestone feed options were considered. It was found that virgin limestones and partially sulfated (in the combustor) limestones do react with SO_2 at the conditions being considered for operation of the CBC. Feeding virgin limestone or limestone that has been partially sulfated in the combustor to the CBC minimizes limestone requirements. The results indicate that highly reactive dolomite requires less limestone (on a weight basis) than does limestone to meet SO_2 emission standards for an AFBC—CBC plant. It should be cautioned that these estimates are made from experimental laboratory data and need confirmation in pilot plant operations. Also these data are valid only for a fluidized-bed combustor which incorporates a carbon burnup cell and are not valid for a fluidized-bed system that recycles the elutriated bed material back to the main combustor.

40226 (M—78-68(Vol.2), pp 763-774) **Limestone utilization optimization in fluidized bed boilers.** Gasner, L.L.; Setesak, S.E. (Univ. of Maryland, College Park). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Limestone or dolomite sorbent utilization in atmospheric fluidized bed boilers must be minimized. This can be done by increasing the reactivity and saturation level of the limestone and by operation of the unit in such a manner as to obtain optimum utilization. The effects of salt addition are summarized in detail. Also mentioned are high temperature treatment, CO_2 dissociation sintering, steam treatment and agglomeration. A dynamic model of sulfur capture in fluidized bed boilers has been developed which predicts sulfur capture and limestone requirements as a function of process variables. Process variables such as bed height, superficial velocity, limestone size, size distribution, reactivity, coal ash properties, bed temperature, excess O_2, and freeboard combustion can be varied. Preliminary results are presented along with a discussion of process operation to minimize sorbent requirements.

40227 (M—78-68(Vol.2), pp 776-785) **Mechanism of the salt additive effect on the SO_2 reactivity of limestone.** Shearer, J.; Turner, C.; Johnson, I. (Argonne National Lab., IL). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Sulfur dioxide capture by nearly all of the limestones observed can be enhanced by adding small amounts of NaCl. The quantity of additive necessary for optimum reactivity of a calcine is dependent on the composition and crystal morphology of the limestone. The mineralizing effect is analogous to high-temperature sintering except that it occurs at greatly accelerated rates at fairly low temperatures. The presence of transient surficial eutectic melts is the reason for increased ionic mobility and diffusion, which in turn results in rearrangement of the component ions with subsequent alterations in pore size and grain size distributions. The increased sulfation is primarily caused by increased permeability of the system to SO_2 and O_2. The high volatility of the salt mineralizer makes it a potentially useful tool for reducing the quantity of solid wastes in fluidized-bed combustion without contributing to the corrosiveness of the system. For example, sorbent could be pretreated with salt in a separate vessel. By selecting suitable treatments of limestones, the amount of alkali added to the system can be kept to a minimum. This study of alkali additives and their effects on limestone sulfation has helped greatly in the understanding of the sulfation reaction itself and the effects of impurities on limestone reactivities in fluidized-bed combustion.

40228 (M—78-68(Vol.2), pp 787-796) **Modelling desulfurization reactions in fluidized bed combustors.** Georgakis, C.; Szekely, J.; Chang, C.W.; Chrostowski, J.W.; Trinh, T. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Two novel gas-solid reaction models are presented for the SO_2 absorption in calcines or dolomites. The first one, the pore plugging model, examines the changes in the geometry of a single pore caused by the fact that the molar volume of $CaSO_4$ is three times larger than that of CaO. For the same reason, the grain size is allowed to increase with conversion in the second model, the expanding grain model. Both models calculate local changes in porosity and evaluate a critical initial porosity below which total conversion is not possible. Analytical solutions of both models at the mouth of the pore or at the surface of the pellet result in the calculation of the pore plugging time after which additional reaction is not possible.

40229 (M—78-68(Vol.2), pp 800-819) **Potential uses for the residue from the fluidized bed combustion process.** Miller, R.H. Sr. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

All indicators show a substantial amount of free lime is available in the FBC residue. Laboratory studies show that the use of the residue in stabilized road base compositions holds considerable promise. In addition, the coarse fraction of the residue can be used as the fine aggregate in a bituminous mix. More study is needed, however, to obtain well designed mixes. The very high strengths that have been obtained in compositions containing fly ash, limestone aggregate, and the residue indicate that other structural products (such as a masonry block) can be made. Blunging of the residue followed by separation by wet tabling is successful in concentrating the free lime in the fine fraction. The use of the blunged material as an SO/sub x/ sorbent gave satisfactory results.

40230 (M—78-68(Vol.2), pp 833-841) **Characterization of fluidized bed combustion waste composition and variability as they relate to disposal on agricultural lands.** Hern, J.L.; Stout, W.L.; Sidle, R.C.; Bennett, O.L. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The chemical composition of fluidized bed combustion waste tends to be variable with respect to many of the components which are of agricultural interest. Liming potential and sulfur composition vary from 20 to 100% and 5 to 15% respectively with relative standard deviations as high as 25%. Analysis of several early samplings show moderate levels of heavy metals which could be of environmental concern. However, later samplings showed a dramatic decrease in the metal composition. More sampling should be carried out to make a more accurate evaluation of this potential problem. Applications of ground FBCW were as effective as those of $Ca(OH)_2$ in increasing soil pH when both materials were applied in equivalent amounts. FBCW applied as a lime source increased the sulfur and manganese contents of tall rescue over equivalent applications of $Ca(OH)_2$. The increase in soil pH brough about by FBCW applications overshadowed the effects of manganese or zinc contained in the FBCW on plant composition. Although it appears that applications of FBCW to agricultural lands may appear beneficial by increasing soil pH and supplying essential plant nutrients, the effect of FBCW on other plant species as well as any potential heavy metal hazard in the food chain must be evaluated before widespread application isrecommended. To this end, other greenhouse and animal nutrition studies are underway but no data is yet available.

40231 (M—78-68(Vol.2), pp 846-873) **Environmental impact of the disposal of processed and unprocessed FBC bed material and carryover.** Sun, C.C.; Peterson, C.H.; Keairns, D.L. (Westinghouse R and D Center, Pittsburgh, PA). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

An understanding of the environmental impact of the disposal of spent sorbent and ash is critical to the successful application of fluidized-bed combustion processes. Laboratory testing programs have been developed to determine the chemical and physical characterization, leaching behavior, and residual activity of the spent FBC materials. Processing of spent FBC sorbent (bed material and carryover) has been studied to investigate the potential for reducing environmental impact. Environmental impact from the disposal of processed and unprocessed FBC sorbent is projected and compared with natural gypsum and FGD spent materials.

40232 (M—78-68(Vol.2), pp 875-890) **Assessment of the impact of SO_2, NO/sub x/, and particulate emission standards on fluidized-bed combustion system design and energy costs.** Newby, R.A.; Ulerich, N.; O'Neill, E.P.; Ciliberti, D.F.; Keairns, D.L. (Westinghouse R and D Center, Pittsburgh, PA). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

An evaluation has been performed to project the impact of potential revised sulfur oxide, particulate and nitrous oxide emission standards on the capital and energy costs of atmospheric-pressure fluidized-bed combustion (AFBC) and pressurized fluidized-bed combustion (PFBC) power plants. Performance and economic projections are presented for current emission standards and for a set of potential revised emission standards. Available data on fluidized-bed combustion performance and system cost show that AFBC and PFBC plants can meet the target New Source Performance Standards (NSPS) and retain economic competitiveness with conventional plants. The selection of plant design and operating parameters, however, is critical to the achievement of these emission levels at competitive energy costs.

40233 (M—78-68(Vol.3)) **Proceedings of the fifth international conference on fluidized bed combustion. Volume III. Development activities.** (Mitre Corp., McLean, VA (USA). METREK Div.). Dec 1978. Contract EX-76-C-01-2453. 880p. (CONF-771272—P3). Dep. NTIS, PC A99/MF A01.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Test installations, instrumentation, mathematical modeling, particulates and removal, corrosion and erosion, and sorbent regeneration. Forty-nine papers from Volume 3 have been entered individually into EDB and ERA. (LTN)

40234 (M—78-68(Vol.3), pp 4-22) **Atmospheric fluidized bed component test and integration facility: an update.** Byam, J.W. Jr.; Wilson, J.S.; Space, C.C. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

To reduce the nation's dependence on foreign energy sources, the Department of Energy (DOE) has taken the lead in promoting and advancing atmospheric fluidized bed combustion projects for the direct utilization of coal in generating electricity and process heat for industry. This paper consists of an update on the design and construction of the Atmospheric Fluidized Bed Component Test and Integration Facility (AFBC/CTIU) which will be sited by DOE on the campus of West Virginia University. The paper presents a brief history of the project, discusses the final facility design parameters and reviews the current procurement/construction progress. The flexibility for equipment configuration changes which have been designed into the facility and its systems is discussed in detail. Plans for the initial testing program at the facility are also discussed.

40235 (M—78-68(Vol.3), pp 24-31) **B and W/EPRI's 6' X 6' fluidized bed combustion development facility: an overview.** Dowdy, T.E.; Bonk, D.L.; Lund, T.E. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The Babcock and Wilcox Company has built, under an Electric Power Research Institute (EPRI) contract, a 6' X 6' atmospheric pressure fluidized bed combustion development facility. This unit is designed to be a versatile, well-instrumented and readily modifiable research tool. It is large enough to bridge the gap between the bench-scale/pilot-scale test facilities now in operation and the large semi-commercial demonstration units now being proposed. The design of the Fluidized Bed Combustion Development Facility began in February 1976. The unit's first firing of coal and generation of steam occurred on October 20, 1977 during the initial shakedown tests. Tests are currently being performed to characterize the unit. The initial test program is designed to characterize coal combustion performance and to gather the heat transfer and other data needed for economic and engineering analyses of the process.

40236 (M—78-68(Vol.3), pp 33-53) **Industrial fluidized bed program: a status review.** Norcross, W.R. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Combustion Engineering is currently developing an industrial fluidized-bed boiler for the combustion of coal. This paper reviews the cold flow modeling and the construction of the hot flow model. Cold flow model testing has been conducted on both two- and three-dimensional flow models to provide design data for the hot scale unit.

40237 (M—78-68(Vol.3), pp 55-71) **Atmospheric fluidized bed combustion technology test unit for industrial cogeneration plants.** Fraas, A.P.; Holcomb, R.S. (Oak Ridge National Lab., TN). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The AFBC Technology Test Unit Program will develop the technology for a fluidized bed coal combustion system to provide a source of high temperature air for process heating and power generation with gas turbines in industrial plants. The gas turbine has the advantages of a higher ratio of electric power output to exhaust heat load and a higher exhaust temperature than do steam turbines in cogeneration applications. This type of system appears to be attractive for development, particularly for installations in the range of 5 to 50 MW(e). The conceptual design of the Technology Test Unit has been completed. The 1.8 m (6 ft)-square combustor has a bed depth of 0.6 m (2 ft) which has been designed for atmospheric pressure and 900°C (1650°F) to produce a heat output of about 1500 kW(t) (5 x 10^6 Btu/hr). A number of furnace design firms have been invited to submit their own designs for the combustor, from which a final selection will be made. Development and testing have been conducted in the areas of fluidization, heat transfer, tube corrosion and coal feeding. New results on heat transfer, tube corrosion and coal feeding are presented in this paper. The TTU program was authorized by ERDA in June 1977, and will require about two years for design, procurement and installation, followed by two years of testing.

40238 (M—78-68(Vol.3), pp 73-80) **ERCO's fluid-bed combustion development facility.** Porter, J.H. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Energy Resources Company Inc. (ERCO) has developed a 6 MMBtu/hr test fluid-bed combustion system. The system has been in operation for 2-1/2 years during which time ERCO has gained a wealth of operating and design experience and data on FBC operations. The unique design of the system allows the rapid alteration of boiler tube configuration to study these effects on boiler performance. As a result of this experience, ERCO has announced its offering of commercial fluid-bed combustion units in sizes from 50 to 250 MMBtu/hr thermal output. ERCO now has under design and construction its new 50 MMBtu/hr demonstration boiler, to be operational by June 1978.

40239 (M—78-68(Vol.3), pp 82-100) **Results of recent test program related to AFB combustion efficiency.** Aulisio, C.; Divilio, R.;

Reed, R.R. (Pope, Evans and Robbins Inc., Alexandria, VA). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Test programs at the Alexandria, Virginia laboratory have been directed toward defining and improving the factors affecting combustion efficiency in atmospheric fluidized-bed combustors. Test programs conducted included determination of the chemical composition of fly ash as a function of particle size and the effect of ash as a function of particle size and the effect of ash recycle to a coal burning cell and to a Carbon—Burnup Cell. The results of these programs indicate that the overall combustion efficiency of an atmospheric fluidized-bed combustor can be increased to over 95% with a fly ash recycle system and to over 99% with a Carbon—Burnup Cell system. In addition the dust collection equipment should be selected to optimize combustion efficiency for a recycle system.

40240 (M—78-68(Vol.3), pp 102-121) **Pressurized fluidized-bed combustion component test and integration unit design status.** Podolski, W.F.; Crawford, R.W. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Argonne National Laboratory is providing technical direction to the design of the Pressurized Fluidized-Bed Combustion/Component Test and Integration Unit (PFBC/CTIU) which is now in progress at the Stearns—Roger Engineering Co. This paper describes the preliminary design of the PFBC/CTIU which is nearly complete at this time. Individual plant systems are described in relation to the design criteria established for the systems. The major goals and objectives of the CTIU are: (1) to test and evaluate components, instrumentation, sampling techniques, control concepts and techniques, and materials of construction proposed for PFBC systems and (2) to investigate alternative PFBC concepts. These goals are being implemented by designing a modular facility with inherent flexibility.

40241 (M—78-68(Vol.3), pp 123-133) **Further experiments on the pilot-scale pressurized combustor at Leatherhead.** Hoy, R.; Roberts, A.; Raven, P. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Recent work on the 3 ft x 2 ft pressurized combustor at Leatherhead has been concerned with operation over a range of fluidizing velocities (2 1/2 and 7 ft/s), deep beds (8 ft) and a tall tube bank (7 ft). Operation was satisfactory at all conditions, but performance at 7 ft/s as regards combustion efficiency, sulfur retention and elutriation was not as good as at 2 1/2 ft/s. Details of these measurements are presented and compared with earlier results.

40242 (M—78-68(Vol.3), pp 135-154) **Solid tracer studies in a tube-filled fluidized bed.** Fitzgerald, T.; Catipovic, N.; Jovanovic, G. (Oregon State Univ., Corvallis). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Coarse sand was fluidized in a one-meter square bed containing an array of horizontal two-inch diameter heat exchange tubes. While the bed was fluidized, ferrite tracer with physical properties similar to coal was injected and monitored by 64 inductance probes located in a four by four by four array inside the bed. The measured tracer movement varied from run to run indicating that the solids flow pattern in the bed changed continuously. The speed with which the tracer spread indicates the effect of gas velocity on solids mixing. In order to design a large fluidized bed combustor it is important to know just how fast solids move through the bed. It is this problem which motivates this study. The bed material, the bed geometry (with heat transfer tubes) and the range of air velocities are representative of fluidized bed combustors.

40243 (M—78-68(Vol.3), pp 156-182) **Effects of finned tubing on fluidized bed performance.** Miller, G.; Zakkay, V.; Kiviat, G. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Under ERDA Contract EF-76-C-01-2256, tests have been conducted in the New York University pilot (one foot diameter) fluidized bed to ascertain the effects of finned tubing on heat transfer. The results are presented as a function of bed pressure, superficial velocity, and air injection pattern. A vertical finned U tube (similar to the one envisioned for industrial applications) was tested, and the results compared to an unfinned tube of exact geometry. Transient heat transfer measurements, as well as overall heat transfer coefficients, are presented to indicate the effects of vertical finned tubing on overall performance. An explanation of the results based on fluid dynamic considerations is provided. In addition, tests were conducted in order to ascertain the effect of bed depth on overall heat transfer performance. The results of these tests are analyzed with respect to the proper length for heat exchangers in fluidized bed facilities.

40244 (M—78-68(Vol.3), pp 184-209) **Industrial application of fluidized bed combustion—single tube heat transfer studies.** Cherrington, D.C.; Golan, L.P.; Hammitt, F.G. (Exxon Research and Engineering Co., Florham Park, NJ). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The purposes of this paper are (1) to review the objectives and status of the DOE supported program on FBC process heaters underway at Exxon and (2) to present some preliminary data from the program on heat transfer coefficients for large horizontal tubes immersed in a fluidized bed of large limestone particles. The goal of the Exxon/DOE FBC program is to make a thorough technical and economic assessment of the FBC concept for refinery and chemical plant fired process heaters. The underlying philosophy of the program is to build on the developments of the boiler oriented programs, concentrating on areas of difference between boilers and process heaters. Two significant areas are being investigated - effects of tube size and hydrocarbon coking. The R and D work in progress includes ambient air fluidization studies on tube bundles containing tubes from two to six inches in diameter, coking studies of a hydrocarbon process stream, and peripheral heat flux measurements on tubes immersed in a fluidized bed. An experimental study where the heat transfer coefficient for large, single horizontal tubes immersed in a fluidized bed was measured has been completed. The heat transfer experiments were conducted on 2 inch diameter tubes with 390 μ, 1000 μ spherical glass beads, and 2, 4, and 6 inch diameter tubes with a blend of limestone particles ranging in size from 200-4,000 μ. Themeasured heat transfer coefficients displayed a dependence on particle diameter, tube diameter, and fluidization velocity. The heat transfer coefficient for the limestone blend exhibited less dependence on the fluidization velocity than the glass beads. Visual observation of the solids movement around the tube circumference and the peripherally measured heat transfer coefficients indicate at least three different heat transfer zones on the tube wall.

40245 (M—78-68(Vol.3), pp 211-221) **Fluidized-bed combustion of lignite and lignite refuse.** Mei, J.S.; Grimm, U.; Rice, R.L.; Halow, J.S. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Lignites comprise about 29 percent of the Nation's solid fuel reserves and constitute a major potential source for future energy needs. Samples of Texas lignite from the Wilcox formation have been investigated at the Morgantown Energy Research Center, U.S. Department of Energy, to assess this fuel as a potential feed stock for fluidized-bed combustors. Combustion tests were performed over a wide range of operating conditions to develop fluidized-bed combustion (FBC) engineering and emissions data on this low-quality fuel. Desirable combustion characteristics observed include: no clinker formation at bed temperature as high as 2000°F, high sulfur retention capability of the mineral from lignite at bed temperature below 1600°F, and freeboard burning of carryover less than expected. Results of these tests indicate that lignite may be a particularly attractive solid fuel for industrial FBC applications. One potential problem with the use of this fuel is formation of very fine ash particles which are difficult to retain in the bed. Use of an attrition resistant bed material was required to maintain bed inventory.

40246 (M—78-68(Vol.3), pp 223-239) **Battelle's Multisolid Fluidized-Bed Combustion process.** Nack, H.; Liu, K.T.; Felton, G.W. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

A novel fluidized-bed combustion process has been developed and called Multisolid Fluidized-Bed Combustion (MS-FBC). Studies in a 6-inch-diameter combustor have demonstrated feasibility of operation at superficial gas velocities exceeding 30 feet per second with good limestone utilization and combustion efficiency. Scale-up studies on a 400 pounds of coal per hour combustor/boiler are in progress. Successful results will lead to a demonstration steam-generator plant of 25,000 pound per hour capacity. A description of the concept and results of studies in the 6-inch-diameter bench-scale unit are presented.

40247 (M—78-68(Vol.3), pp 241-252) **Pneumatic solids injector and start-up burner for Battelle's Multisolid Fluidized-Bed Combustion (MS-FBC) Process.** Felton, G.W.; Giammar, R.D.; Hazard, H.R.; Taylor, D.R. (Battelle Columbus Labs., OH). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Two important and innovative components have contributed to the successful operation of Battelle's Multisolid Fluidized-Bed Combustion Process: a pneumatic solids injector and a start-up burner. This paper, appropriately in two parts, describes each equipment's development, design, and test. Part I describes how Battelle has developed and successfully combustor-tested a novel pneumatic injector for feeding solids into the bottom of a fluidized-bed against back pressures of up to four psi. The injector was sized to feed 600 pounds per hour of 1/8 x 0 material using 1/2 pound of air per pound of solids fed. In the process downstream air from the injector is bypassed back through a control valve into the injector solids entrance stream to reduce the solids inlet vacuum to any desired low level. Part II describes how Battelle selected the gas turbine can-type burner because it operates stably over a wide range of firing rates (50 to 1), air/fuel ratios (100 to 1) and pressures (up to 15 atm). Due to its high heat-release rate, (8.5×10^6 Btu/hr-ft^3 atm), it is extremely compact and provides uniform gas-outlet temperatures.

40248 (M—78-68(Vol.3), pp 275-286) **Combustion experiments within a rotating fluidized bed.** Metcalfe, C.I.; Howard, J.R. (Univ. of Aston, Birmingham, Eng.). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Rotating fluidized bed combustors offer the exciting prospects of raising the rate of heat release per unit volume of bed to dramatically high levels and extending the range of 'turn down' significantly. Results obtained with a gas-fired fluidized bed combustor are discussed briefly and followed by an account of experience obtained when burning coal, (anthracite). The latter work exposed some of the problems to be overcome before the full potential of this combustion system can be realized. Start-up, control and segregation problems are described and the direction which future work should take is discussed.

40249 (M—78-68(Vol.3), pp 288-298) **Centrifugal fluidized bed combustion.** Levy, E.K.; Martin, N.W.; Chen, J.C. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Centrifugal fluidized bed combustion is a relatively new concept for coal combustion, where the bed rotates about its vertical axis of symmetry and the fluidizing air flows radially inward through the porous cylindrical surface of the distributor. Lehigh University has been involved in analysis and experiments with centrifugal beds since 1974 and is presently performing room temperature fluidization experiments. Data are presented on the effects of particle size, bed mass, angular velocity, distributor taper angle and distributor pressure drop on minimum fluidization and bed pressure drop. Analyses which predict bed shape, minimum fluidization and bed pressure drop are described and compared with the data.

40250 (M—78-68(Vol.3), pp 310-321) **Technical description of the plant design and project progress report.** Broadbent, D.H.; Wright, S.J. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The history leading up to the agreement to build a fluidized-bed facility at Grimethorpe, near Barnsley, Yorkshire in England is lengthy and has been given in the paper to the Fluidized-Bed Combustion Technology Exchange Workshop here in Washington earlier this year. In summary the scheme for the present program of building a pressurized fluidized-bed research facility stems from the setting up in 1974 of the International Energy Agency, for which the NCB was invited to establish the Coal Working Group under the chairmanship of Mr. Leslie Grainger, NCB's then Member for Science. Five priority agreements emerged from the working group, one of which is the building of the experimental Fluidized-Bed Combustion Plant. In order to formally manage the five projects, NCB (IEA Services) Ltd., a wholly owned subsidiary of the NCB was set up, and from the signing in 1975 of the implementing agreement, a tripartite agreement was reached between the United Kingdom, United States, and the Federal German Republic to build the experimental facility, having commenced in November 1975 and due for completion in early 1979 with the subsequent experimentation for an additional four years.

40251 (M—78-68(Vol.3), pp 362-378) **Particle field diagnostics system for fluidized bed combustion facilities.** Bachalo, W.D. (Spectron Development Labs., Inc., Costa Mesa, CA). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Particle diagnostics instrumentation that have been developed for application in fluidized bed combustion plants is described. The devices have been designed to make simultaneous on-line measurements of particle diameter over two decades of size range and of the particle velocity for the determination of particle flux or concentration. These ruggedized, laser-based, light-scatter, detection instruments make use of angular scattering intensity ratios for sizing particles in the range 0.5 to 10μm in diameter and particle sizing interferometry (visibility) in the range 2 to 100μm in diameter. A brief description of the physics involved is given together with a discussion of other available techniques.

40252 (M—78-68(Vol.3), pp 379-402) **Particulate sampling system for pressurized fluidized bed combustors.** Masters, W.; Larkin, R. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

A particulate sampler for high-temperature, high-pressure processes has been developed and successfully demonstrated. The system uses an extractive approach, removing samples from the process stream for complete analysis of particulate size distribution, morphology, and chemical composition. System capabilities have been demonstrated by sampling a pressurized fluidized bed combustor. This paper describes the extractive sampling approach, the HTHP sampler design, and the data obtained from sampling operations.

40253 (M—78-68(Vol.3), pp 406-435) **FBC-modelling and data base.** Tung, S.E.; Goldman, J.; Louis, J.F. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

MIT has organized a broad-based multi-disciplinary group working toward the establishment of a system model for the technology of environmentally compatible use of coal. The overall objectives of the project are: (1) to establish a comprehensive system model that is sufficiently precise to be suitable for process and engineering design optimization; and (2) to establish a data base system that will reposit all relevant data on coal based FBC (fluidized bed combustor) in a single site and can be used to answer various queries from remote sites. It is proposed to achieve these broad objectives in several phases. The initial phase, which is currently being conducted, has more limited goals: to develop an initial system model using mainly the state-of-the-art information; and to select and implement a data base management system suitable for FBC.

40254 (M—78-68(Vol.3), pp 437-456) **Model of coal combustion in fluidized bed combustors.** Baron, R.E.; Beer, J.M.; Borghi, G.; Hodges, J.L.; Sarofim, A.F. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

This paper describes the development of a model to predict the carbon combustion efficiency in a fluid bed combustor (FBC). The model is part of a larger program aimed at producing a comprehensive model of total system performance. In order to predict carbon combustion efficiency, it is necessary to be able to predict burning times of individual particles. Therefore, a detailed model for single coal particle combustion has been developed. This detailed model has been used to develop kinetic parameters which can be utilized in the system model and provides an approximate procedure for accounting for the differences in coal reactivity, as manifested by differences in B.E.T. surface and effective pore diameter. System model predictions of carbon combustion efficiency are in reasonable agreement with limited experimental data. The model currently provides a means for evaluating the effects on carbon combustion efficiency of mean bed temperature, coal and acceptor particle sizes and physical properties, superficial velocity, excess air, and bed height. A number of approximations are incorporated into the system model and there is a need for a continuous critical evaluation and refinement of the model as data becomes available from pilot plant and demonstration units.

40255 (M—78-68(Vol.3), pp 458-473) **Fluid dynamic modelling of fluidized bed combustors.** Bar-Cohen, A.; Glicksman, L.; Hughes, R. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The dynamics of gas bubbles rising and growing within the solids/gas emulsion are today known to define the operating characteristics of many practical fluidized beds and, in small-particle systems, have been shown to follow the two-phase theory. The present effort focuses on the fluid mechanics of large particle fluidization, as is anticipated for fluidized bed combustors, and extends the two-phase theory to this important fluidization category. The results

suggest that two-phase theory, when combined with an appropriate bubble-frequency relation, can provide an accurate prediction of bubble size and bubble fraction and their variation with height in the bed. Furthermore, examination of these relations in light of the particle sizes and air flow rates proposed for prototype fluidized bed combustors suggests that an appreciable part of bed operation will be in slow-bubble regime where much of the emulsion gas flows through the bubble void. In this regime, gas flow through the bed can be modelled as plug flow and thus provides substantially less resistance to mass transfer than is encountered in the conventional, fast-bubble regime. The results of the present work suggest the following conclusions: large-particle fluidized beds have flow regimes radically different from small-particle beds; the slow-bubble regime and the transition from slow to fast bubble flow regimes are veryimportant for large-particle systems, (the two-phase hypothesis appears to be valid for large-particle beds); the classical bubble models used in the two-phase theory have limitations in large-particle systems due to overlapping clouds near flow transition and the inapplicability of D'Arcy's law; and the bubble size can be approximated by the use of experimental frequency correlations.

40256 (M—78-68(Vol.3), pp 475-486) **Mechanistic model to explain ash agglomeration in fluidized bed combustors and gasifiers.** Saxena, S.C. (Univ. of Illinois, Chicago); Rehmat, A. Dec 1978.
From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

A mechanistic model for ash agglomeration has been proposed in which the higher internal temperature of a reacting particle for a given bed temperature under certain favorable conditions will melt the inorganic ash and which in view of its high surface tension will ooze out of the particle and will merge with similar ash beads to form agglomerates. The frame work of mathematical equations describing this model are derived and have been solved for a range of operating and system variables. The experimental data generated at IGT have been discussed in detail and explained on the basis of proposed theory.

40257 (M—78-68(Vol.3), pp 488-500) **Dynamic modeling, testing, and control of fluidized bed systems.** Berkowitz, D.A.; Ray, A.; Sumaria, V.; Wilson, M. (MITRE Corp., Bedford, MA). Dec 1978.
From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The method of process modeling and model validation leading to analytical control system design, which is finding increased application in conventional fossil and nuclear generating units, can advantageously be applied to fluidized bed combustion systems. The modeling and testing program at Alexandria has demonstrated that the modeling method adequately represents process dynamic interactions, and information useful for analytical control system design, such as input and output matrices of the linearized system at several load levels and frequency dependent input—output transfer functions, can be derived readily from the validated nonlinear process model. In general, fluidized bed systems are nonlinear, multivariable, and interactive. Although classical controllers based on individual single-input single-output control loops may be specified for such systems as a first step in formulating the controller structure, alternate analytical control design methods seem more promising. Time domain design using a family of linearized models and a quadratic cost functional performance index has already been applied to generating unit controller problems. Frequency domain design using a family of linearized models and state feedback to achieve decoupling of output variables seems very appropriate, and offers a way to apply conventional single-input single-output frequency response-methods more effectively.

40258 (M—78-68(Vol.3), pp 504-514) **Evaluation of a granular bed filter for particulate control in fluidized bed combustion.** Nutkis, M.S.; Hoke, R.C.; Gregory, M.W.; Bertrand, R.R. Dec 1978.
From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

In a pressurized fluidized bed coal combustion system where the flue gas is expanded through a gas turbine to achieve greater cycle efficiency, it is important that the particulate emissions be at a level satisfying both turbine and environmental requirements. A program in progress using the EPA—Exxon Research pressurized fluidized bed coal combustor is evaluating the effectiveness of a granular bed filter to remove particulates from the high pressure, high temperature flue gas. A 24-hour shakedown run was accomplished in August 1977. Main problems are with filter cleaning at system conditions, filter plugging and loss of filter media.

40259 (M—78-68(Vol.3), pp 516-536) **Granular bed filters for particulate removal at high temperature and pressure.** Yung, S.C.; Parker, R.D.; Patterson, R.G.; Calvert, S.; Drehmel, D.C. Dec 1978.
From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The technological status of granular bed filtration for particulate control at high temperature and pressure (HTP) is critically examined with regard to applications for fluidized bed combustion (FBC) processes. A performance model for granular bed filtration is presented and compared with experimental data from laboratory and industrial scale filters. The potential of granular bed filters for HTP particulate control is evaluated with regard to the cleanup requirements based on turbine limitations, emissions regulations and current information on the size and mass loading of particulate emitted from FBC processes.

40260 (M—78-68(Vol.3), pp 538-549) **Particulate removal from pressurized hot gas.** Yamamura, R. (Japan Coal Mining Research Center, Tokyo, Japan); Terada, H. Dec 1978.
From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

This paper describes cold and hot test programs for developing a new particulate removal system which contains moving bed filters and fluidized bed regeneration of alumina balls. Based on cold modelling tests studying such problems as movement of balls in the bed, control of ball discharge rate and dust removal efficiency, it is concluded that this system should be very feasible. Hot gas programs have been carried out in the use of a one-stage test filter set for the raw gas line of a 5 T/D pressurized coal gasifier in Yubari City. It is confirmed that one could attain high removal efficiency of about 90 to 97%. This indicates that a two or three-stage particulate removal system will satisfy the inlet condition of a gas turbine.

40261 (M—78-68(Vol.3), pp 551-565) **Particulate removal from hot gases using the fluidized bed cross-flow filter.** Gutfinger, C.; Tardos, G.I.; Degani, D. (Israel Inst. of Tech., Haifa). Dec 1978.
From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

This work describes a granular filter for separation of particulates from a hot gas. The device operates in a steady state mode by means of continuous introduction of clean filter granules from the top and removal of dirty granules from the bottom. The gas flows transversely across the moving active filter material. A bench scale sand filter of 100 cm^2 cross-section was constructed and tested during this work and its filtration and hydrodynamic characteristics are reported. A theoretical model for the computation of filtration efficiencies is also presented.

40262 (M—78-68(Vol.3), pp 567-581) **Filtration performance of a moving bed granular filter: experimental cold flow data.** Guillory, J.L. Dec 1978.
From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Data from an ERDA-sponsored experimental study relating certain mechanical and process parameters (superficial velocity, dust loading, dust size, media rate, media size, bed thickness and bed height) to the particulate collection efficiency and pressure drop of a moving bed granular filter is presented. It is shown that, by proper selection of bed configuration and certain operational variables, removal efficiencies in excess of 98% and outlet dust loadings less than 20 parts per million (weight basis) can be achieved for inlet particulate sizes and loadings associated with many combustion operations.

40263 (M—78-68(Vol.3), pp 607-619) **Multiple jet particle collection in a cyclone by reheating fluidized bed combustion products.** Tsao, K.C.; Yung, K.T.; Bradley, J.F. (Univ. of Wisconsin, Milwaukee). Dec 1978.
From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

A new particle collection technique is analyzed and presented for its potential application in high temperature and high pressure gas cleaning systems. The new technique is based on the probability of particle collision and agglomeration phenomena by reheating fluidized bed combustion products near coal-ash fusion temperature. The entrapped solids after impactions will agglomerate and adhere together to form into larger sizes for effective separation under centrifugal action. A mathematical model is constructed leading to the design of an experimental high temperature cyclone. Effect of particle jet geometry and velocity distribution is discussed for the highest rate of generation of new particles.

40264 (M—78-68(Vol.3), pp 620-639) **Feasibility of barrier filtration using ceramic fibers.** Shackleton, M.A. (Acurex Corp., Mountain View, CA). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Barrier filtration using ceramic fiber filters offers a promising solution to the problem of controlling particles in the high-temperature, high-pressure environment. Industrial experience has proven this technique is capable of high efficiency particle control, including fine particles, in near ambient temperatures and pressures. Examining those particle removal mechanisms which apply to barrier filtration indicates that adverse effects caused by increased gas viscosity at high temperatures can be compensated for in the design of the filter medium and in the design of the filter system. Ceramic fibers are available which have smaller diameters (3μm) than conventional fibers used for filters (10 to 20 μm). Analysis indicates that using these fine diameter fibers should make it possible to produce filter media having weights less than or, at most, equal to conventional media. This paper reports on work being performed under EPA Contract 68-02-2169 to demonstrate the feasibility of high-temperature, high-pressure particle control by filtration. Tests at room ambient have shown the filtration capability of ceramic fiber beds. Tests at high temperature and pressure have demonstrated several ceramic media configurations capable of withstanding in excess of 50,000 cleaning pulse cycles. To solve the high temperature gas cleaning problem for FBC application rapid development ofthis technology is clearly needed.

40265 (M—78-68(Vol.3), pp 660-680) **Erosion/corrosion of turbine airfoil materials in the high-velocity effluent of a pressurized fluidized coal combustor.** Zellars, G.R.; Rowe, A.P.; Lowell, C.E. (National Aeronautics and Space Administration, Cleveland, OH). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Four candidate turbine airfoil superalloys have been exposed to the effluent of a pressurized fluidized bed with a solids loading of 2-4 g/scm for times up to 100 hours at two gas velocities, 150 and 270 m/sec, and two temperatures, 730°C and 795°C. Under these conditions, both erosion and corrosion occurred. The damaged specimens were examined by cross-section measurements, scanning electron and light microscopy, and X-ray analysis to evaluate effects of temperature, velocity, particle loading, and alloy material. Results indicate that for a given solids loading, the extent os erosion is primarily dependent on gas velocity. Hot corrosion occurred at the higher temperature. There was little difference in the response of the four alloys tested under these severe conditions.

40266 (M—78-68(Vol.3), pp 682-698) **High-temperature corrosion of metals and alloys in fluidized bed combustion systems.** Stringer, J.; La Nauze, R.D.; Rogers, E.A. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

It is clear from these experiments, and from other experiences reported in the literature, that while fluidized bed combustors can operate with no corrosion at all, there is a risk of sulfidation/oxidation corrosion of high temperature metal components. Once initiated, this form of attack can produce very rapid local degradation of alloys sensitive to this type of corrosion. The conditions which are likely to lead to this type of attack are: the presence of calcium sulfate as a deposit on the metal surface, the existence of a local region of low oxygen activity near the metal, the presence of a sensitive alloy in the low oxygen activity region, and metal temperatures above 650°C. The factors that determine whether or not a calcium sulfate layer forms on the tubes are not understood. Some of the factors likely to affect the existence of low oxygen activity regions have been listed, and it may be possible to optimize bed operation to eliminate the corrosion risk. The most important contribution of the present investigation has been to establish that alloys such as Inconel 671, Incoloy 800, Inconel 617 and perhaps Haynes Alloys 188 are sensitive to corrosion in the bed; but the stainless steels such as Types 304, 329 and 347 are relatively insensitive; they do sulfidize but the morphology of the sulfidation does not appear to lead to catastrophic attack. Further work is clearlyrequired on these aspects. Experiments should be conducted to determine the local oxygen activities within the bed, and the effect of operating variables on the oxygen distribution. The testing of the more resistant materials should be extended to longer times to ensure that the sulfidation/oxidation attack does not eventually become catastrophic.

40267 (M—78-68(Vol.3), pp 700-712) **Thermal stresses and fatigue of heat transfer tubes immersed in a fluidized bed combustor.** Decker, N.; Glicksman, L.; Pelloux, R.; Shen, T. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Thermal stress conditions are investigated for horizontal tubes in a fluidized bed combustor. Circumferentially non-uniform temperatures and high frequency cycle temperature distributions are projected from observed heat transfer variations on tubes immersed in fluidized beds. The thermal stress produced by the external heat transfer variations are shown to be less important than that caused by internal variations due to the boiling two-phase flow within the tube. High cycle fatigue due to external heat transfer fluctuations is shown to be unlikely. Low cycle fatigue due to cyclic microyielding during each start—stop cycle of the bed was also investigated. Using fatigue data for 304 stainless steel, it can be concluded that low cycle fatigue failure will not occur.

40268 (M—78-68(Vol.3), pp 740-754) **Thermodynamics of regenerating sulfated lime.** Rassiwalla, F.M.; Wheelock, T.D. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The thermodynamics of a high temperature reductive decomposition process for regenerating the lime sorbent which has become sulfated in a fluidized bed cobustor are analyzed to reveal the process characteristics and to show the effects of various operating conditions on process performance. For this analysis it is assumed that the reaction system is in thermodynamic equilibrium. The effects of temperature, pressure. and reducing state on the extent of desulfurization, sulfur dioxide concentration, and the fuel and energy requirements are shown. Also the effects of using different types of fuel including coal and methane for regeneration are indicated.

40269 (M—78-68(Vol.3), pp 756-774) **Pressurized fluidized bed coal combustion and sorbent regeneration.** Ruth, L.A.; Hoke, R.C.; Nutkis, M.S.; Bertrand, R.R. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Pressurized fluidized bed coal combustion is being studied both with once-through addition of sorbent to the combustor and also with continuous sorbent regeneration. During once-through operation, SO_2, NO/sub x/, and other gaseous emissions were measured and correlations were developed which permit estimation of the amount of sorbent required to meet the EPA emission standard for SO_2. Bed-to-tube heat transfer coefficients and carbon combustion efficiency were also determined. During a five day run to demonstrate regeneration, sorbent circulated continuously between the combustor and regenerator. Compared to a once-through system, requirements of make-up sorbent were reduced by at least a factor of four.

40270 (M—78-68(Vol.3), pp 776-795) **Development of a process for regenerating partially sulfated limestone from FBC boilers.** Montanga, J.C.; Nunes, F.F.; Smith, G.W.; Smyk, E.B.; Teats, F.G.; Vogel, G.J.; Jonke, A.A. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

In fluidized-bed combustion of high-sulfur coal, a natural calcium-containing stone such as limestone or dolomite is used as the bed material and acts as the sulfur-accepting agent, forming $CaSO_4$. A means of significantly reducing waste volume from the combustor is regeneration of the $CaSO_4$ to CaO and reuse of the regenerated stone in the combustor. A fluid-bed, reductive-decomposition, regeneration process has been developed in which the sensible heat, the heat of reaction, and the reducing gases are supplied by partial combustion of coal in the bed at 1100°C. The developmental stages are reported for: (1) selection of the process, (2) evaluating the regenerator performance with limestone, (3) performing cyclic (sulfation—regeneration) limestone and dolomite life studies, and (4) incorporating the experimental results in such a process flowsheet for a 200-MWe FBC boiler—regenerator system. Reductive decomposition of $CaSO_4$ at 1100°C in a fluidized bed is a technically viable process for regenerating CaO for reuse in the combustion process. Sufficient regeneration is obtained in such a short time (a few minutes) that the regeneration reactor can be relatively small. The SO_2 concentration in the off-gas is sufficiently high so that the sulfur can be recovered using commercially available processes. Data from the cyclic studies and flowsheet studies have demonstrated that the quantity of stone required per ton of coal processed is significantly less (~ 1/5) when the stone is regenerated than when the stone is used only once and then discarded. Costs of the regeneration process and the once-through processes must be compared to determine economic viability.

40271 (M—78-68(Vol.3), pp 798-809) **Regeneration of lime-based sorbents in a kiln with solid reductants.** Yang, R.T.; Chen, J.M.; Farber, G.; Shen, M.S.; Steinberg, M. (Brookhaven National Lab., Upton, NY). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Processes based on apparent solid—solid reactions in a kiln-type reactor for regenerating the lime-based sorbents are being developed. The specific process investigated is to react the sulfated lime with fly ash, both from the fluidized-bed combustor (FBC). The unburned carbon in the fly ash is used as the reductant. Eight-cycle sulfation—regeneration based on this scheme has been experimented using Greer lime and fly ash from Argonne's 6-inch FBC as the starting materials. The apparatus included a rotary-kiln regenerator and a fluidized-bed sulfator, both and a ca 10-gram capacity and made of quartz. The kiln temperature was 1000°C in the cyclic experiments. The SO_2 concentration reached the thermodynamic equilibrium values at slow gas flow rates. The reactivity of the regenerated sorbent did not decay appreciably after eight cycles; it actually tended to increase due to the impurities absorbed in the kiln. Completion of the regeneration of the 30%-sulfated stone from FBC could be reached in an hour with a time-averaged SO_2 concentration of 5% from the kiln. Attrition in the kiln is much less than in a FB regenerator. Because of the low gas flow required in this process, high SO_2 concentration can be obtained at relatively low temperatures in comparison withthe fluidization regeneration process. The high regenerability in a reasonably short solid residence time, the less detrimental effect of temperature on the reactivity of the regenerated sorbent and potentially less solid attrition make the kiln regeneration process look promising. The kiln regenerator may also serve the function of the carbon burn-up cell and thus replaces it.

40272 (M—78-68(Vol.3), pp 811-830) **Evaluation of sorbent regeneration processes for AFBC and PFBC.** Newby, R.A.; Katta, S.; Keairns, D.L. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Projections of the economics of regenerative fluidized-bed combustion power plants (atmospheric-pressure and pressurized boilers) have been developed on the basis of current estimates of regeneration system performance. Economic comparisons with fluidized-bed combustion power plants operated with once-through sorbent systems and with conventional coal-fired power plants using limestone wet-scrubbing are presented. Regenerative FBC performance requirements for economic feasibility are projected and critical development needs are discussed.

40273 (M—78-68(Vol.3), pp 832-849) **Engineering study on the regeneration of sulfated additive from a fluidized-bed coal-fired power plant.** Bianco, J.H.; Huber, D.A.; Morton, J.W.; Costello, R.M. (Burns and Roe Industrial Services Corp., Paramus, NJ). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Under DOE sponsorship (Contract No. EX-76-C-01-2371), an engineering study of the regeneration of sulfated additives from a coal-fired fluidized-bed power plant was performed. The work involves a review of the literature, selection of a viable process to be used, preparation of conceptual flow diagrams, identification of required equipment and order-of-magnitude cost estimates for the complete sulfated sorbent processing and handling system. The system was sized to service a 600 megawatt power plant. Several alternative arrangements of the one-step regeneration process were studied and compared to a once-through sorbent system.

40274 (M—78-68(Vol.3), pp 851-863) **Economic feasibility of regenerating sulfated limestones.** Smyk, E.B.; Montagna, J.C.; Vogel, G.J.; Jonke, A.A. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Regeneration of the $CaSO_4$ in the spent sorbent of a fluidized-bed combustor and recycle of the resulting CaO offers a means of reducing the waste disposal burden of this technology. A fluidized-bed reductive decomposition limestone regeneration process has been developed in PDU-scale equipment. Predictions from a model based on these experiments combined with cost data developed by Westinghouse allows net costs to be determined for various operating and economic parameters. Economic feasibility will depend on the values selected for these factors. A framework is provided for analyzing specific cases.

40275 (METC/RI—79/4) **Fluidized-bed combustion of high sulfur coals.** Mei, J.S.; Halow, J.S.; Grimm, U.; Rice, R.L. (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center). Apr 1979. 149p. Dep. NTIS, PC A07/MF A01.

A program was initiated in late 1977 at the Morgantown Energy Technology Center, Department of Energy to evaluate the sulfur retention capability of an atmospheric fluidized-bed combustor (AFBC) burning a high sulfur coal in light of the EPA proposed New Source Performance Standards and their potential impact on AFBC technology. A high volatile bituminous Pittswick coal with 4.52 percent sulfur content was selected for this study. Greer limestone as well as Tymochtee dolomite were used as sulfur sorbents. Combustion tests were carried out at various operating conditions to develop AFBC engineering and emissions data on this high sulfur coal. Ninety or greater percent of sulfur retention was attained in 9 of the 19 balance periods. Eighty-five or greater percent sulfur retention was attained in 14 of the 19 balance periods. The results of the present tests clearly demonstrate that the proposed new standards for sulfur dioxide emissions can be met by AFBC's.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 41763

REGULATIONS

REFER ALSO TO CITATION(S) 40232, 41645

PETROLEUM

RESERVES

40276 (PB—287394) **Northern Alaska hydrocarbon resources. Commission study.** Kreitner, J.D. (Federal-State Land Use Planning Commission for Alaska, Anchorage (USA)). May 1978. 79p. NTIS PC A05/MF A01.

This report on Northern Alaska hydrocarbon resources brings together the private, federal, and state oil and gas initiatives in Northern Alaska over the past 35 years. It treats Northern Alaska oil and gas provinces as a planning unit, rather than using the classic (private, state, etc.) divisions.

GEOLOGY AND EXPLORATION

40277 **Effect of temperature and pressure on the dependence of electrical resistance as a function of water saturability of sandy collectors.** Avchyan, G.M.; Stefankevich, Z.B. *Razved. Geofiz.;* No. 72, 153-156(1976). (In Russian).

Results are presented on an experimental study of the effect of temperature and pressure on the dependence of the saturation parameter as a function of the water-gas saturability of sand-clay ores in productive deposits of the Uzen' oil field in south Mangushlak. It is shown that at a deposit depth of 1.5 to 2 km the strata conditions have an insignificant effect on the dependence of the saturation parameter as a function of water saturability in comparison with atmospheric conditions. With a further increase in temperature the effect of this dependence increases.

DRILLING AND PRODUCTION

40278 (BETC—1800-40) **El Dorado Micellar-Polymer Demonstration Project. Fourth annual report, September 1977—August 1978.** Rosenwald, G.W. (ed.). (Department of Energy, Washington, DC (USA)). Apr 1979. Contract ET-78-C-03-1800. 309p. Dep. NTIS, PC A14/MF A01.

Specifications were determined for the surfactant concentrate and Abbott xanthan gum broth to be used in the north (Chesney) pattern and the Nalco polyacrylamide concentrate to be used in the south (Hegberg) pattern. Results are given for oil displacement tests using the south pattern micellar-polymer fluid sequence in reservoir cores. The data from observation wells MP-131 and MP-227 indicate the breakthrough of alcohol and surfactants. These chemicals at the observation wells signal the probable arrival of the oil banks. Salinity remained constant in the production wells during the last year. The pressures in the project monitoring wells were measured six times during this reporting period. Temperature profiles were determined in four south pattern wells during micellar (soluble) oil injection since it had been shown that allowing the micellar oil to cool would adversely affect its injectivity. The addition of a wax inhibitor and a solvent to the Greenwood County crude oil used in the micellar oil improved the fluid injectivity. Performance monitoring, performance forecasting, and associated program development work have been undertaken. A study of monitoring well pressures indicates a possible west-to-east pressure gradient. An analysis of micellar fluid injectivity data for the north pattern shows that most of the injectivity losses have been caused by sandface skin. Forecasts of flood-

front locations illustrate the effects of well rate balance and pressure gradient on areal sweep.

40279 (BETC—8002-1) **Bradford Field, Pennsylvania micellar-polymer flood. Penn Grade Crude Oil Association, quarterly report, October 1—December 31, 1978.** Danielson, H.H. (Department of Energy, Bartlesville, OK (USA). Bartlesville Energy Technology Center). 4 Mar 1979. Contract EY-76-C-21-8002. 6p. Dep. NTIS, PC A02/MF A01.

Objective of this field test is to demonstrate oil recovery from a low-permeability depleted waterflood using a micellar fluid followed by polymer solution. The micellar slug injection phase was completed on April 11, 1978. Polymer injection has continued in the spike phase. Average production rate for the period was 11.7 BOPD and 403 BWPD for a WOR of 34. (DLC)

40280 (DOE/BC/00038—1) **Technological evaluation of the drilling industry and its long range requirements.** (Williams Bros. Engineering Co., Tulsa, OK (USA)). Mar 1977. Contract EW-78-C-19-0038. 103p. Dep. NTIS, PC A06/MF A01.

This study evaluates the drilling equipment industry and determines oil field drilling equipment products that should be considered for a development program. Besides listing oil field equipment products suitable for development, it also determines cost/time factors involved in the development and defines product benefit factors in terms of improved drilling rig productivity. (DLC)

40281 **Use of phenol alcohols for insulation operations.** Eremin, G.A.; Krylov, V.I.; Usov, S.V. *Neft. Khoz.;* No. 1, 24-28(Jan 1979). (In Russian).

Results are given for industrial tests of phenol alcohol use as a plugging material during well insulation operations. A method is given for determining the nature of phenol alcohol congealing, and recommendations are offered for preventing its mixture with the drilling solution. 2 references, 1 figure, 4 tables.

40282 (SAN—1265-9) **Transient flow of non-Newtonian power-law fluids in porous media.** Ikoku, C.U.; Ramey, H.J. Jr. (Stanford Univ., CA (USA)). Sep 1978. Contract EY-76-C-03-1265. 271p. Dep. NTIS, PC A12/MF A01.

The objective of this study was to examine the basic characteristics of transient injection of a power-law non-Newtonian fluid. A new nonlinear partial differential equation for flow of power-law fluids was derived. The diffusivity equation is a special case of this equation. The new partial differential equation describes the flow of a slightly compressible, non-Newtonian power-law fluid in a homogeneous and isotropic porous medium. This equation should govern the flow of most nont agents used in enchanced oil recovery projects. A linear form of the partial differential equation was also derived. A model for the flow of foam in porous media gave rise to another nonlinear partial differential equation which considers the compressibility of foam, and the pressure-dependent quality of foam. Analytical solutions of the transient and steady-state forms of the linear partial differential equation were obtained. The solutions for the constant-rate, infinitely large reservoir case appear to permit new methods of well test analysis for non-Newtonian fluids. A polymer injection well test example was synthesized and an interpretation presented toillustrate potential field applications of the new well test analysis methods. Finite-difference solutions were also obtained for the infinitely large reservoir case. Other boundary conditions studied include the constant injection rate, no-flow outer boundary case, and the constant injection rate, constant-pressure outer boundary case. Wellbore storage and skin effects were also investigated. Injection well falloff testing for infinitely large reservoirs was also considered. This gave rise to new methods of injection well falloff test analysis for non-Newtonian fluids. Wellbore storage effects were considered for this case also. Log-log type curves were presented for all the conditions studied.

40283 (SAND—79-0821C) **Examination of thermally efficient steam injection techniques for DEEP reservoirs.** Fox, R.L. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 9p. (CONF-790460—2). Dep. NTIS, PC A02/MF A01.

From Society of Petroleum Engineers California regional meeting; Ventura, CA, USA (18 Apr 1979).

The physical phenomena which limit the depth for economic enhanced recovery of heavy oil by steam injection are individually examined. The ability of techniques for thermally efficient delivery of surface generated steam to address these phenomena is analyzed. Experimental test facilities for comparison of various approaches to improving thermal efficiency developed through the Department of Energy's Project DEEP STEAM are described. 11 figures.

40284 **Method for generating hydrofluoric acid in a subterranean formation.** Salathiel, W.M.; Shaughnessy, C.M. (to Exxon Production Research Co.). US Patent 4,136,739. 30 Jan 1979. Filed date 19 Aug 1977. 16p.

A method is disclosed for generating or forming hydrofluoric acid in a subterranean siliceous formation by combining an injected aqueous solution of a fluoride salt and an injected aqueous acid solution in the pore spaces of the formation. This is accomplished according to this invention by immobilizing one of the aqueous solutions in the pore spaces of the formation by displacing the aqueous solution into the formation with a liquid that is substantially immiscible with the injected aqueous solution, thereby driving said aqueous solution to a saturation at or below its residual saturation. The other aqueous solution is then injected into the formation.

40285 **Use of rank classification for estimating the coefficient of oil recovery.** Mirzadzhanzade, A.Kh.; Vakhitov, G.G.; Maksutov, R.A.; Graifer, V.I. *Neft. Khoz.;* No. 1, 29-31(Jan 1979). (In Russian).

An examination is made of a new methodological system for estimating the coefficient of stratal oil recovery that was tested in the operation of 93 fields on the Apsheron peninsula. 3 references, 3 tables.

40286 **Effectiveness of the cyclic pumping of water in the Soviet deposits.** Ganich, K.A.; Dergunov, V.K.; Iahemguzhin, S.B. *Neft. Khoz.;* No. 1, 31-34(Jan 1979). (In Russian).

Results are given for cyclic pumping of water in bed A_1 of the Soviet field, and a method is given for determining the effectiveness of cyclic treatment of the bed. The need of increasing the duration of the semicycle of water pumping was demonstrated. 3 figures, 1 table.

40287 **Classification of waterflooding systems of deposits of the geosynclinal type.** Nabiev, G.I.; Pirverdyan, A.M.; Listengarten, L.B.; Danielyan, I.A.; Babaev, V.D. *Neft. Khoz.;* No. 1, 34-35(Jan 1979). (In Russian).

An examination is made of the characteristics of Azerbaidzhan deposits that have been operated with waterflooding. The use of various methods of flooding for specific geological-physical conditions is determined on the basis of analyzing the effectiveness of flooding systems. 2 figures.

40288 **Method for determining the yield of new wells in the oil fields of western Siberia.** Baturin, Yu.E. *Neft. Khoz.;* No. 1, 35-36(Jan 1979). (In Russian).

A method is proposed for determining yield by elastic drive formulas. The starting information is the geological-physical characteristics of a bed in the drilling site of a new well, as well as the face and stratal pressure at the time of the well's drilling. 2 references.

40289 **Terminology and classification of methods for the artificial treatment of oil strata.** Belyanin, G.N. *Neft. Khoz.;* No. 1, 39-42(Jan 1979). (In Russian).

A classification is offered for treatment methods that divides the treatments into two groups depending on their purpose. The groups are further divided into subgroups with respect to the mechanism of treatment, and subdivisions of the subgroups with respect to the technology of the treatment. 1 figure.

40290 **Results of experimental studies of deep/stratal water purification by electrocoagulation.** Zhdanov, I.A.; Aliev, A.D. *Neft. Khoz.;* No. 1, 43-45(Jan 1979). (In Russian).

The dependence of petroleum concentration in purified water and the amount of precipitating slime on the consumption of electric power and of the purification effect on the settling time were shown. A significant mineralization of stratal waters was shown to make it possible to achieve a high level of purification with small expenditures of electric power. The purpose of the study was to determine economic and technical feasibility of reinjecting formation water in offshore drilling and production operations.

40291 **Changes in the production cost of oil recovery as a function of waterflooding economics of forced recovery.** Shchelkachev, V.N. *Neft. Khoz.;* No. 1, 7-11(Jan 1979). (In Russian).

A simple relationship between production cost and the degree of waterflooding was established on the basis of petroleum production costs in the USSR and the USA. This formula and the parameters computed by it make it possible to estimate the effect that the increase in the fluid yield of a flooded oil well has on the recovery costs. This is very important for the economics of forced recovery. 3 references, 4 tables.

40292 **Improvement of the technology of field-geophysical operations.** Mukher, A.A.; Laptev, V.V.; Dembitskii, S.I. *Neft. Khoz.;* No. 1, 12-18(Jan 1979). (In Russian).

An examination is made of measures whose use increased the informativity of field-geophysical studies in an open shaft of a well. An improvement in the quality of the information content of the geophysical studies was shown to make it possible to reduce the time required to drill wells by 10 to 15%. 2 tables.

40293 Improvement in the quality of compiling complex plans for the drilling and development of fields. Gabasov, G.Kh.; Sharipov, A.U. *Neft. Khoz.;* No. 1, 18-20(Jan 1979). (In Russian).

Examples are given for the deterioration of technological-economic indicators of oilfield operations that resulted from discrepancy between well construction design and the conditions under which the operational system functions. The need for connecting problems in a rational operation to the planning of well construction is demonstrated. 8 references, 1 figure.

40294 Drilling oil beds containing hydrogen sulfide in a depression regime. Mazur, V.P.; Levkin, V.T.; Mezhlumov, A.C.; Perov, A.V.; Vakula, Ya.V.; Zhutaev, A.M.; Zhzhenov, B.G.; Ermolaev, Yu.A. *Neft. Khoz.;* No. 1, 20-22(Jan 1979). (In Russian).

Laboratory studies are given for the neutralization of hydrogen sulfide which resulted in establishing that aqueous solutions of sodium hydroxide with a concentration of 0.2 mass % have sufficient activity to neutralize the H_2S. A description is given of drilling technology in a producing bed with the use of air. 1 figure, 1 table.

40295 Determining the optimal depression during formation testing in an open borehole. Myasnyankin, Yu.M.; Shinbaum, S.A.; Shmigel'skaya, T.N. *Neft. Khoz.;* No. 1, 23-24(Jan 1979). (In Russian).

A method is given for computing permissible depression that accounts for the condition of borehole strength. The Mizes condition was adopted as the safety criterion for the stress state. A computational example is given. 4 references.

40296 Conductor and riser design for fixed drilling platforms in the marine environment. Adams, C.J.; Burnell, A.J. (CJB-Earl and Wright Consulting Engineers, London, England). pp 107-128 of Marine environment and oil facilities. London, England; Institution of Civil Engineers (1979).

From Marine environment and oil facilities; London, UK (20 Sep 1978).

Oil well conductor and oil export riser design for North Sea fixed drilling and production platforms is reviewed from a structural engineering viewpoint. The primary purposes of the conductor pipe are outlined with an emphasis on the requirements for supporting internal casing strings and resisting external environmental loads. Corrosion protection of the oil export riser is highlighted as a critical design problem. Finally, the combined influence of conductors and risers on the main tower design is discussed. The oil export riser is concluded to be a more vulnerable portion of the oil flowline than conductors although the consequences of damage or deterioration of the oil export riser are slight compared to the effects of damage to the main oil well conductor.

40297 Norwegian legislation concerning contingency planning. Stavland, A. pp 141-147 of Marine environment and oil facilities. London, England; Institution of Civil Engineers (1979).

From Marine environment and oil facilities; London, UK (20 Sep 1978).

The presentation given in this paper is confined to the existing Norwegian legislation concerning contingency planning for emergency situations which may arise in connection with drilling and production activities on the Norwegian continental shelf. This includes a presentation of the basic principles which the licensee must observe when preparing his contigency plans. Further, a presentation of public administrative responsibility as well as public response to emergency situaions related to offshore activities is included.

PROCESSING

REFER ALSO TO CITATION(S) 40159, 40207

40298 Process for recovering molybdenum, vanadium, cobalt and nickel from roasted products of used catalysts from hydrotreatment desulfurization of petroleum. Toida, S.; Ohno, A.; Higuchi, K.; Higuchi, M.; Higuchi, M.; Higuchi, Y. (to Marubeni Corp.; Fuji Fine Chemical Co., Ltd.). US Patent 4,145,397. 20 Mar 1979. Priority date 6 Aug 1976, Japan, 22p.

From roasted products of used catalysts from hydrotreatment desulfurization of petroleum, valuable molybdenum, vanadium, cobalt and nickel are recovered easily and a high percent recovery by means of a combination of simple chemical procedures and also inexpensive chemicals. The recovered metal components can be reused for preparing new catalysts and the like.

40299 Process for treating a sour petroleum distillate. Carlson, D.H.J.; Deering, J.R. (to UOP Inc.). US Patent 4,142,964. 6 Mar 1979. Filed date 1 Jun 1978. 6p.

A process for treating a mercaptan-containing sour petroleum distillate is disclosed. The process comprises contacting the distillate with a supported metal phthalocyanine catalyst in the presence of an alkaline reagent at oxidation conditions, the catalyst having been prepared by impregnating the phthalocyanine on a solid adsorptive support from an aqueous solution or dispersion of the phthalocyanine containing from about 5 to about 50 wt ppM morpholine.

40300 Hydrocarbon conversion with an attenuated superactive multimetallic catalytic composite. George, J.A.; Antos, G.J. (to UOP Inc.). US Patent 4,137,153. 30 Jan 1979. Filed date 3 Mar 1978. 28p.

Hydrocarbons are converted by contacting them at hydrocarbon conversion conditions with a novel attenuated superactive multimetallic catalytic composite comprising a combination of a catalytically effective amount of a pyrolyzed rhenium carbonyl component with a porous carrier material containing a uniform dispersion of catalytically effective amounts of a platinum group component, which is maintained in the elemental metallic state, and of a zinc component. In a highly preferred embodiment, this novel catalytic composite also contains a catalytically effective amount of a halogen component. The platinum group component, pyrolyzed rhenium carbonyl component are preferably present in the multimetallic catalytic composite in amounts, calculated on an elemental basis, corresponding to about 0.01 to about 2 wt % platinum group metal, about 0.01 to about 5 wt % rhenium, about 0.01 to about 5% zinc and about 0.1 to about 3.5 wt % halogen. A key feature associated with the preparation of the subject catalytic composite is reaction of a rhenium carbonyl complex with a porous carrier material containing a uniform dispersion of a zinc component and of a platinum group metal maintained in the elemental state, whereby the interaction of the rhenium moiety with the platinum group moiety is maximized due to the platinophilic (i.e., platinum-seeking) propensities of the carbon monoxide ligand used in the rhenium reagent. A specific example of the type of hydrocarbon conversion process disclosed herein is a process for the catalytic reforming of a low octane gasoline fraction wherein the gasoline fraction and a hydrogen stream are contacted with the subject superactive multimetallic catalytic composite at reforming conditions.

40301 Hydrocarbon conversion with cracking catalyst having co-combustion promoters lanthanum and iron. Csicsery, S.M. (to Chevron Research Co.). US Patent 4,137,151. 30 Jan 1979. Filed date 25 Feb 1977. 14p.

A composition useful in hydrocarbon conversion processes such as catalytic cracking comprises 0.05 to 10 weight percent lanthanum associated with a refractory support. The composition may also include 0.02 to 10 weight percent iron. The refractory support is a zeolitic crystalline aluminosilicate.

40302 Catalytic hydrofining process. Mickelson, G.A. (to Union Oil Co. of California). US Patent 4,113,605. 12 Sep 1978. Filed date 28 Oct 1977. 8p.

Carbonates and/or hydroxides of one or more of the Group VIII metals, cobalt and nickel, are reacted with molybdic acid in aqueous suspension to form a slurry of crystalline cobalt and/or nickel molybdate, which slurry is then reacted with gelatinous boehmite alumina, then extruded, dried and calcined. The method eliminates the use of ammoniacal solutions, washing and/or heating steps to remove undesired anions or cations, and requires but a single drying and calcination. The resulting catalysts are found to be very active for the desulfurization and denitrogenation of mineral oils.

40303 Cracking catalyst activity maintenance for catalytic cracking process. Schwarzenbek, E.F. US Patent 4,098,678. 4 Jul 1978. Filed date 22 Aug 1977. 8p.

The activity maintenance of silica containing catalysts used in catalytic cracking operations is improved by the addition to the system of a silica containing compound or mixture which is in a form and in an amount that will readily vaporize in the steam added to or formed in the process. By the method of operation, the refiner is able to realize substantial savings in the amount of catalyst make-up required to maintain a given activity level in the unit.

MARKETING AND ECONOMICS

40304 (DOE/EIA—0102/48/1) Macroeconomic effects of petroleum supply interruptions. Volume I. Curtis, W.P. (Department of Energy, Washington, DC (USA). Energy Information Administration). Mar 1979. 89p. Dep. NTIS, PC A05/MF A01.

This report analyzes the macroeconomic effects of ten alternative oil embargo scenarios. The scenarios differ with respect to the intensity and duration of the shortfall in petroleum imports, the amount of the world oil price increase, the application of U.S. petroleum price controls and product allocation regulations, and the extent to which the Strategic Petroleum Reserve (SPR) is used. Shortfalls occur simultaneously throughout the oil-importing world. They are assumed to occur during all or part of 1980, and the effects on the U.S. economy over the 1980—1982 period are analyzed. The effects of the shortfalls were simulated with two different macroe-

conomic models of the U.S. economy: the Wharton Econometric Forecasting Associates (WEFA) Annual Energy Model of the United States, and the Data Resources, Inc. (DRI) Econometric Model of the U.S. Economy. The DRI model was used in conjunction with a model of petroleum allocation and industrial production developed by Scientific Applications, Inc. (SAI). Not all scenarios were simulated on all models. Scenarios and associated model results are summarized in Tables S1 and S2.

40305 (DOE/EIA—0102/48/2) **Macroeconomic effects of petroleum supply interruptions. Volume II.** Curtis, W.P. (Department of Energy, Washington, DC (USA). Energy Information Administration). Mar 1979. 243p. Dep. NTIS, PC A11/MF A01.

This volume contains the following appendices on the SAI-DRI methodology, and statistical results for both WEFA and DRI model simulations: the SAI Allocation model; changes made to DRI model variables in generating shortfall simulations; and results from WEFA and DRI model simulations for those variables for which the Macroeconomic Analysis Division was requested to provide data to the Office of Policy and Evaluation.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 40815

40306 (BETC/RI—79/5) **Clay-contacting re-refined lubricating oils: a parameter study.** Reynolds, J.W.; Brinkman, D.W.; Whisman, M.L. (Department of Energy, Bartlesville, OK (USA). Bartlesville Energy Technology Center). Apr 1979. 14p. Dep. NTIS, PC A02/MF A01.

Variation of some parameters involved in clay contacting reclaimed lubricating oil for color and odor improvement has been studied. Laboratory experiments were conducted in which temperature, oil to clay ratio, steam sparge rate, and the amount of acid were varied to determine a set of optimum conditions. 13 figures, 7 tables.

40307 (PB—287568) **Waste oil in Alaska. An evaluation of waste oil general and disposal, and recommendations for use and conservation. Task a report: waste oil generation and disposal.** (Tryck, Nyman and Hayes, Anchorage, AK (USA)). Oct 1977. 117p. NTIS PC A06/MF A01.

This report contains information, data and analysis of past and current practices of disposing of waste oil in Alaska. It also contains a review of the impacts of waste oil on the environment; a review of the City and Borough of Juneau's waste oil disposal program; and a bibliography of past studies, reports and documents on the topic of waste oil.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 40182, 41666, 41670

40308 **Marine environment and oil facilities.** London, England; Institution of Civil Engineers (1979). 167p. (CONF-7809143—).

From Marine environment and oil facilities; London, UK (20 Sep 1978).

Seven papers are included which discuss the marine environment, legislation, engineering technology, and management. Separate abstracts were prepared for all seven papers. (DCL)

40309 (NTIS/PS—78/1256) **Oil water separators (citations from the NTIS data base). Report for 1964—December 1978.** Smith, M.F. (National Technical Information Service, Springfield, VA (USA)). Dec 1978. 154p. NTIS PC N01/MF N01.

The citations cover Federally-sponsored research on these devices, primarily for oil pollution control. Centrifuge separators, coalescers, filters, and skimmers are included. Oil recovery from oil spills, and seperation from ballast and bilge water are also cited. The operation, testing, and performance of this equipment in the laboratory and in the field are reported. (This updated bibliography contains 146 abstracts, 6 of which are new entries to the previous edition.)

40310 (NTIS/PS—78/1257) **Oil water separators (citations from the Engineering Index data base). Report for 1970—1978.** Smith, M.F. (National Technical Information Service, Springfield, VA (USA)). Dec 1978. 134p. NTIS PC N01/MF N01.

Worldwide journal research is cited on these devices, mainly for water pollution control. A range of equipment is described, including gravity separators, centrifuges, membranes, coalescers, filters, distillation columns, and flotation units. Oil recovery from oil spills is covered. Separation of these components in ballast and bilge water, factory effluents, petroleum refineries, and waste oil treatment is studied. Design, operation, costs, testing, and efficiency of these articles are reported. (Contains 128 abstracts)

40311 (NTIS/PS—78/1258) **Oil water separators (citations from the american petroleum institute data base). Report for 1973—August 1978.** Smith, M.F. (National Technical Information Service, Springfield, VA (USA)). Dec 1978. 145p. NTIS PC N01/MF N01.

Citations cover research on these devices primarily for oil pollution control. Equipment studied includes coalescers, filters, skimmers, scrubbers, absorbers, centrifuges, and sweeps. Oil recovery from oil spills, separation from bilge and ballast water, and removal from petroleum refinery effluents are described. The operation, testing, and performance of this equipment in the laboratory and in the field are reported. (Contains 140 abstracts)

40312 **Sources and effects of hydrocarbons in the marine environment.** Johnston, C.S. (Heriot-Watt Univ., Edinburgh, England). pp 23-39 of Marine environment and oil facilities. London, England; Institution of Civil Engineers (1979).

From Marine environment and oil facilities; London, UK (20 Sep 1978).

Against a background resume of the major toxic effects of petroleum hydrocarbons on marine life, the relevant importance of their different input routes to the marine environment is assessed. Particular attention is given to the potential application of hydrocarbon data in environmental baseline and monitoring programs.

40313 **Development of the Department of the Environment's Pollution Paper No 8: Accidental Oil Pollution of the Sea.** Crane, G.D. (Departments of the Environment and Transport, London, England). pp 49-63 of Marine environment and oil facilities. London, England; Institution of Civil Engineers (1979).

From Marine environment and oil facilities; London, UK (20 Sep 1978).

This paper discusses the background to the writing of Accidental Oil Pollution of the Sea, the way the team which prepared the study was organized, and the consultations which took place in the course of preparing the report. It also attempts to draw some conclusions about the methods of conducting such studies.

40314 **Some environmental controls in the Murchison Field.** Pappworth, S.S.R. pp 93-106 of Marine environment and oil facilities. London, England; Institution of Civil Engineers (1979).

From Marine environment and oil facilities; London, UK (20 Sep 1978).

The internal and external environment have been considered in the development of the Murchison Field. A data base is to be established by conducting a survey of the biological activity and chemical levels of the water and sediments. Examples are given of the prevention and treatment approaches to environmental control. If the control measures fail, emergency procedure plans have been formulated.

POLICY, LEGISLATION, AND REGULATION

40315 (PB—288656) **Cooking with offshore oil: a handbook for California local government.** Chorich, M. (University of Southern California, Los Angeles (USA). Inst. for Marine and Coastal Studies). Aug 1978. 243p. NTIS PC A11/MF A01.

The handbook is divided into six parts: (1) a brief introduction to the leasing process and Outer Continental Shelf (OCS) development issues; (2) an OCS Issues Chart, summarizing and bringing together the material presented; (3) dissection of development issues and recommendations for planning recipes; (4) policy options open to local governments; (5) recommendations by policy makers involved in the OCS development process concerning promising courses of action, and (6) the Appendices and Bibliographic references. The Appendices contain the correspondence, resolutions, comments and ordinances local governments have used to respond to OCS development.

40316 **Legislation for offshore facilities in the marine environment.** George, H.R. (Department of Energy, London, England). pp 65-81 of Marine environment and oil facilities. London, England; Institution of Civil Engineers (1979).

From Marine environment and oil facilities; London, UK (20 Sep 1978).

A survey has been made of the development of legislation and regulation of petroleum exploration and production activities on the UK Continental Shelf. The roles of the inspectorate and the certification authorities in ensuring the adherence to the various safety codes is discussed; Government establishes the broad principles which must be adopted and monitors the conduct of operators to satisfy itself that these principles are followed. The latter part of the paper is concerned with the measures to protect the interests of other users of the sea. The key elements being notification, consulta-

tion, preventative action, contingency planning and compensation for damage caused.

PROPERTIES

REFER ALSO TO CITATION(S) 40203

40317 Dielectric properties and aggregate stability of water-petroleum emulsions. Sayakhov, F.L.; Khakimov, V.S.; Arutyunov, A.I.; Dem'yanov, A.A.; Baikov, N.M. *Neft. Khoz.;* No. 1, 36-39(Jan 1979). (In Russian).

Experimental data are given on the settling dynamics of water-petroleum emulsions after 30-hours in an electrical field of industrial frequency, high frequency, and in combined fields. An attempt is made to explain the obtained results from the physics viewpoint. 7 references, 4 figures.

40318 Method of operative identification of petroleum grades by dielectric constant . Babeev, N.G.; Musaev, M.M. *Neft. Khoz.;* No. 1, 46-48(Jan 1979). (In Russian).

An examination is made of the dielectric method of evaluating the grade of petroleum by measuring the dielectric constant of a dessicated petroleum film. Metrological substantiation is offered for the method, and the results of experimental studies are indicated. Ways are indicated for using this method for the purpose of measuring the moisture content of petroleum. 2 tables, 2 figures, 9 references

STORAGE

REFER ALSO TO CITATION(S) 41237

40319 (PB—287281) Transportation planning for the Strategic Petroleum Reserve should be improved. (General Accounting Office, Washington, DC (USA). Logistics and Communications Div.). 18 Oct 1978. 18p. NTIS PC A02/MF A01.

The report recommends that the Secretary of Energy develop, and make available to appropriate congressional committees, a comprehensive transportation plan for the Strategic Petroleum Reserve. The plan should include detailed transportation cost estimates. Firm information on the costs and other effects of the Cargo Preference Act also should be generated and included.

COMBUSTION

REFER ALSO TO CITATION(S) 40203

NATURAL GAS

RESERVES

REFER ALSO TO CITATION(S) 40276

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 40637

40320 (DOE/FERC—0029) Nonconventional natural gas resources. (Stanford Univ., CA (USA)). Mar 1979. 223p. Dep. NTIS, PC A10/MF A01.

It is concluded that it is impossible at this time to forecast the volume of natural gas dissolved in water that can be economically recovered. The investigation to southern Louisiana, both onshore and offshore was confined. Estimates of the dissolved methane content are based upon information on temperatures, pressures, sandstone thicknesses, sandstone porosities, salinity, and the solubility of methane. The salinity of waters encountered in wells was estimated from wireline logs, and in turn used to reduce the estimated content of dissolved gas. The reductions range from 51 to 61 percent of the solubility of methane in fresh water. The assessment does not include gas dissolved in water contained in shale beds. A series of maps display the information used in the computation. Methane solubility values were multiplied by porosity—feet values for each 1000-foot interval. The total dissolved methane in the resource base is estimated to be 6,143 trillion cubic feet (Tcf); assumptions on the effect of salinity reduce this to 3,264 Tcf. This figure does not include methane beneath the Texas coast. Very preliminary estimates of the recoverable proportion of dissolved gas in the highly "geopressured" zones range from 1 to over 20 percent. Not all of the resource base estimates of 3,264 Tcf occurs in the highly geopressured zone, and the proportions individually allocatable within the resource base to the highly "geopressured" zone, to the intermediate-pressure zone, and to the normal or "hydropressure" zone cannotbe estimated readily. The environmental aspects of recovery of dissolved gas are also presented. The review is necessarily generalized, since it could not be based on actual experience. The problems include subsidence of land surface and possibly increased seismic activity. Fluid withdrawal might result in subsidence of the land surface, as well as activation of growth faults, with adjustments extending to the surface.

DRILLING, PRODUCTION, AND PROCESSING

REFER ALSO TO CITATION(S) 40292

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 41113

40321 Prospects for using natural gas in light transportation vehicles. Porter, J.W.; Grosser, M. Arlington, VA; American Gas Association (1978). 47p. (NP—23762). American Gas Association, 1515 Wilson Blvd., Arlington, VA.

Motivated by both energy-supply and air-quality considerations, a substantial technical effort is now being directed toward alternative light-vehicle technologies. This report provides a preliminary assessment of the current and expected role of natural gas (whose primary component is methane) as an alternate light-vehicle fuel, particularly as it compares to gasoline, diesel, and electrical vehicles. Primary attention in this analysis is given to passenger automobile applications. Major conclusions of the assessment are first presented. Then, summaries are given of the history of gas-fueled engines; brief technical comparisons of natural gas (i.e., methane), gasoline, diesel, and electrical engine technologies; performance and cost comparisons; and a forklift-truck case study.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 41622

ENVIRONMENTAL EFFECTS

REFER ALSO TO CITATION(S) 41622

40322 (UCRL—13984) Technical report remote sensing of LNG spill vapor dispersion using Raman LIDAR. Leonard, D.A.; Caputo, B. (Computer Genetics Corp., Wakefield, MA (USA)). Mar 1979. Contract W-7405-ENG-48. 121p. Dep. NTIS, PC A06/MF A01.

Portions of document are illegible.

The report describes a field experiment which evaluated the remote sensing of hydrocarbon concentrations in the dispersing cloud of gas produced by a spill of LNG using a Raman LIDAR technique. Included in this report are the background and objectives of the effort; a description of the lidar equipment; a description of the test site and the test scenario; and sections on data analysis and recommendations.

40323 (UCRL—81812) Impact of LNG spills on the environment: a comparison of dispersion models and experimental data. Bowman, B.R.; Sutton, S.B.; Comfort, W.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 9 Jan 1979. Contract W-7405-ENG-48. 6p. (CONF-790445—1). Dep. NTIS, PC A02/MF A01.

From 19. annual meeting of the institute of environmental sciences; Seattle, WA, USA (29 Apr 1979).

To assess the potential fire and detonation hazards from possible liquefied natural gas (LNG) spills, it is necessary to accurately predict the downwind dispersion of the vapor. This paper compares two dispersion-model calculations with experimental data collected for 5-m^3 spills of LNG on water. The two dispersion models are a Guassian dispersion model, which includes models for vapor generation and gravity spread, and a three-dimensional solution of the compressible turbulent transient Navier—Stokes equations and associated equations for conservation of species and energy. The latter model was also run in a two-dimensional mode to evaluate the utility of two-dimensional calculations. These calcula-

tions are compared to data collected in LNG spill and dispersion experiments, which measured the concentration of hydrocarbons at several downwind locations. The adequacy of and differences between the models are discussed, and areas for model improvement are indicated.

ARTIFICIAL STIMULATION, PLOWSHARE, ETC.

40324 (DOE/BG/01569—3) **Western Gas Sands Project. Status report, 1 January 1979—31 January 1979.** Atkinson, C.H. (CER Corp., Las Vegas, NV (USA)). 1979. Contract AC08-79BG01569. 81p. Dep. NTIS, PC A05/MF A01.

Aim is to increase gas production from the low-permeability gas sands of the western U.S. Progress is reported on: project management, resource assessment, R and D at various facilities, and field tests and demonstrations. (DLC)

40325 (DOE/BG/01569—5) **Western Gas Sands Project. Quarterly basin activities report.** Atkinson, C.H. (CER Corp., Las Vegas, NV (USA)). 31 Jan 1979. Contract AC08-79BG01569. 61p. Dep. NTIS, PC A04/MF A01.

This report is a summation of 3 months' drilling and testing activities in the four primary WGSP study areas: Greater Green River Basin, Northern Great Plains Province, Piceance Basin, and Uinta Basin. The monitoring of basin activities is part of resource assessment. (DLC)

40326 (NVO—0623-1(Vol.1)) **Rio Blanco massive hydraulic fracture well RB-MHF-3. Final report.** (CER Corp., Las Vegas, NV (USA)). 29 Dec 1978. Contract EY-76-C-08-0623. 51p. Dep. NTIS, PC A04/MF A01.

The Rio Blanco Massive Hydraulic Fracturing Project was fielded in 1974 as a joint Industry/ERDA demonstration to test the relative effectiveness of MHF in the same formations that were stimulated by the Rio Blanco nuclear fracturing experiment. The project is essentially a companion effort to and a continuation of the preceding nuclear stimulation project, which took place in May, 1973. The well was fractured a total of four times, twice in the Upper Mesaverde and twice in the Fort Union. A fifth zone in the Upper Mesaverde was extensively tested but abandoned as being of insufficient quality for fracturing. In the four treatments, none appears to have fractured laterally as designed. In the Fort Union and Mesaverde each well must produce from numerous sand lenses, the lateral extent of which appears to be limited.

40327 (NVO—0623-1(Vol.3)) **Rio Blanco massive hydraulic fracture well RB-MHF-3. Final report.** (CER Corp., Las Vegas, NV (USA)). 29 Dec 1978. Contract EY-76-C-08-0623. 198p. Dep. NTIS, MF/A01.

Portions of document are illegible.

This volume contains the following appendixes: daily well reports, analysis of temperature surveys, pressure buildup analysis, job sheets and pressure charts, breakdowns and MHF, production data, analysis of produced liquids.

40328 (UCRL—52656) **Survey of gas quality results from three gas-well-stimulation experiments by nuclear explosions.** Tewes, H.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Jan 1979. Contract W-7405-ENG-48. 38p. Dep. NTIS, PC A03/MF A01.

Gas quality results obtained at LLL on samples taken from the three nuclear gas-well-stimulation experiments (Gasbuggy, Rulison, Rio Blanco) are used to illustrate the differences and similarities of the three projects. All of the gas analysis data shown here have been previously published in LLL reports, but heretofore, intercomparisons have been difficult because of the different formats used in the various publications. Also, the data from the three expriments have not previously been manipulated in the same way so that postshot conditions in the three cavity and chimney systems could be compared. As the pressure and temperature increase in the cavity and chimney system (as they do with increasing depth of burial) the amount of water produced with the chimney gas increases markedly. Differences in late-time additions of CO_2 to the chimney gas were also observed. Previously reported radiological safety studies of the potential effects from the use of nuclearly stimulated gas are discussed, and the required steps that could lead to the possible sale of nuclearly stimulated gas to the general public are listed.

POLICY, LEGISLATION, AND REGULATION

40329 (DOE/EIA—0183/1) **Modeling natural gas regulatory proposals using the Project Independence Evaluation System.** Murphy, F.H.; Sanders, R.C.; Shaw, S.H.; Thrasher, R.L. (Department of Energy, Washington, DC (USA). Energy Information Administration). May 1979. 51p. Dep. NTIS, PC A04/MF A01.

This paper describes the modeling of natural gas regulations as contained in the House bill (H.R. 8444), the Senate bill (H.R. 5289) and the natural gas Compromise as of May 3, 1978. The purpose of this exercise was to analyse the impacts on energy markets of the proposed legislation. This work was done at the request of the Senate Commmittee on Energy and Natural Resources.

40330 (DOE/FERC—0030) **Interim manual of instructions for producer compliance with provisions of the Nautral Gas Policy Act of 1978.** (Federal Energy Regulatory Commission, Washington, DC (USA)). 27 Apr 1979. 101p. Dep. NTIS, PC A06/MF A01.

On Nov. 9, 1978, President Carter signed into law the Natural Gas Policy Act of 1978 (NGPA). This manual was prepared to help gas producers understand the NGPA, what must be done to comply with it, and what is necessary in order to collect the prices to which they may be entitled. (DLC)

TRANSPORT, PIPELINES, AND HANDLING

40331 (RLO—2229/T15-6) **Comprehensive bibliography and index of environmental information along the three alternative gas pipeline routes. Supplement No. 1.** Buck, E.H.; Allen, A.; Olshansky, R.B.; Pennell, S.H. (Alaska Univ., Anchorage (USA). Arctic Environmental Information and Data Center). Jan 1979. Contract EY-76-S-06-2229-015. 75p. Dep. NTIS, PC A06/MF A01.

This bibliography of 141 references was compiled to provide increased access to environmental information pertinent to the three alternative natural gas pipeline routes from Prudhoe Bay through Alaska (only the Alaskan segment of each was included). Environmental features within 15 miles of any segment of the routes are covered. The following indexes are included: author, geographic, map, earth sciences, biological (taxonomic), and general keyword. (DLC)

COMBUSTION

REFER ALSO TO CITATION(S) 40200, 40248

40332 (M—78-68(Vol.3), pp 268-273) **Research of gas combustion in fluidized bed plants.** Makhorin, K. Y.; Glukhomanyuk, A.M. (Inst. of Gas of the Ukrainian SSR Academy of Sciences, Kiev, USSR). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Fluidized-bed combustion of gas can be organized by various techniques, the most characteristic of them being: combustion of a homogeneous gas-and-air mixture injected through a gas-timing grate; combustion of gas partially mixed with air outside the fluidized bed; and combustion of gas and air injected into the fluidized bed by separate jets. All these methods were studied with the use of experimental systems both in laboratory and industrial conditions.

OIL SHALES AND TAR SANDS

DRILLING, FRACTURING, AND MINING

40333 (SAND—79-0563C) **Oil shale fracture and fragmentation at high rates of loading.** Grady, D.E.; Kipp, M.E. (Sandia Labs., Albuquerque, NM (USA)). 27 Mar 1979. Contract EY-76-C-04-0789. 14p. (CONF-790606—8). Dep. NTIS, PC A02/MF A01.

From 20. US symposium on rock mechanics; Austin, TX, USA (3 Jun 1979).

Dynamic fracture and fragmentation data on oil shale obtained by various impact or explosive methods indicate significant rate dependence in fracture behavior. A model of the fracture process based on activation and growth of preexisting flaws has been successful in explaining the dynamic behavior and in correlating both static and dynamic tensile strength data for oil shale.

OIL PRODUCTION, RECOVERY, AND REFINING

IN SITU METHODS, TRUE AND MODIFIED

40334 (SAND—78-1818) **Oil shale programs. Tenth quarterly report, April 1978—June 1978.** Stevens, A.L. (ed.). (Sandia Labs.,

Albuquerque, NM (USA)). Apr 1979. Contract EY-76-C-04-0789. 74p. Dep. NTIS, PC A04/MF A01.

Work is being performed under three programs: diagnostic and rock mechanics support for the Laramie In Situ-Oil Shale program, advanced instrumentation and field projects for in-situ oil shale processing, and in-situ oil shale bed preparation study.

40335 (SAND—79-0041C) **Material balance calculations for true in-situ oil shale retorting.** Hommert, P.J. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 16p. (CONF-790440—1). Dep. NTIS, PC A02/MF A01.

From 12. oil shale symposium; Golden, CO, USA (18 Apr 1979).

In an effort to further understand the characteristics of true in situ oil shale retorting, a comprehensive material balance procedure has been developed for this application. In addition to the normal elemental balances, laboratory data for the stoichiometry of oil coking and kerogen decomposition are used. This additional information allows estimates to be made as to the extent of the product loss mechanisms of oil coking and oil combustion. Assumptions are necessary in order to close the balance; thus sensitivity of the results to these assumptions is examined. The procedure has been applied to both the Site 9 and, on a preliminary basis, Site 12 oil shale retorts conducted by the Laramie Energy Technology Center. Results indicate that oil combustion and oil coking are significant loss mechanisms, i.e., on the order of 40 to 60% of oil retorted.

40336 (SAND—79-0158) **Oil shale programs. Quarterly report, July 1978—September 1978.** Stevens, A.L. (ed.). (Sandia Labs., Albuquerque, NM (USA)). Apr 1979. Contract EY-76-C-04-0789. 30p. Dep. NTIS, PC A03/MF A01.

Work is reported in the following three separate programs: Diagnostics and Rock Mechanics Support for the Laramie In Situ Oil Shale program (Site 12 retorting and fracturing), Advanced Instrumentation and Support Projects for In Situ Oil Shale Processing, and In Situ Oil Shale Bed Preparation. (DLC)

40337 (SAND—79-0751) **Oil shale programs. Quarterly report, October 1978—December 1978.** Stevens, A.L. (ed.). (Sandia Labs., Albuquerque, NM (USA)). May 1979. Contract EY-76-C-04-0789. 47p. Dep. NTIS, PC A03/MF A01.

Work is being done in three programs: Diagnostics and Rock Mechanics Support for the Laramie In Situ Oil Shale program, Advanced Instrumentation and Field Projects for In Situ Oil Shale Processing, and In Situ Oil Shale Bed Preparation. Progress is reported in each program. (DLC)

REFINING

REFER ALSO TO CITATION(S) 40300, 40301

PROPERTIES AND COMPOSITION

REFER ALSO TO CITATION(S) 40333, 41366

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 41619, 41620, 41763

40338 (LA-UR—79-1014) **Inhalation toxicology of oil shale-related materials.** Holland, L.M.; Spall, W.D.; Garcia, L.L. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-26. 17p. (CONF-790447—3). Dep. NTIS, PC A02/MF A01.

From Health implications of the new energy technologies; Park City, UT, USA (4 Apr 1979).

An effort was made to integrate industrial hygiene studies and chemical analyses with inhalation toxicology experiments in order to identify the pulmonary hazards that may arise from an oil shale industry. Results indicate that raw shale dusts cause very little epithelial or fibrotic reaction. Retorted shales elicit inflammatory reaction with varying degrees of fibrosis and epithelial hyperplasia. The shale dusts appear as agglomerations rather than as individual particles, with a peribronchiolar pattern. The chemical availability of total hydrocarbons and polycyclic aromatics varies inversely with particle size.

ENVIROMENTAL ASPECTS

40339 (PNL—2910) **Review of air quality assessment studies and definitions of some research needs for the emerging oil shale technology.** Parker, G.B. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1979. Contract EY-76-C-06-1830. 46p. Dep. NTIS, PC A03/MF A01.

This paper reviews the air quality assessment programs that have been conducted by the various private and government sponsored developers who propose to extract energy from the oil shale. These studies have ranged from regional comprehensive baseline and environmental impact studies over several years' period to intermittant localized small scale air quality monitoring programs. A review of the environmental programs, their location, retorting type, and extent of environmental program undertaken is given.

NUCLEAR FUELS

40340 (PNL—2822) **Depleted uranium valuation.** Lewallen, M.A.; White, M.K.; Jenquin, U.P. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1979. Contract EY-76-C-06-1830. 32p. Dep. NTIS, PC A03/MF A01.

The following uses for depleted uranium were examined to determine its value: a substitute for lead in shielding applications, feed material in gaseous diffusion enrichment facilities, feed material for an advanced enrichment concept, Mixed Oxide (MOx) diluent and blanket material in LMFBRs, and fertile material in LMFBR systems. A range of depleted uranium values was calculated for each of these applications. The sensitivity of these values to analysis assumptions is discussed. 9 tables.

40341 **Breeding nuclear fuel with accelerators: The electronuclear method. Nuclear physics aspects.** Barashenkov, V.S. (Joint Institute for Nuclear Research, Dubna). *Sov. J. Particles Nucl. (Engl. Transl.);* 9: No. 5, 452-472(Sep 1978).

The current state of the problem is reviewed. Application of nuclear reactions is considered for conversion of ^{238}U and ^{232}Th into the easily fissile isotopes ^{239}Pu and ^{233}U, for creation of unique high-intensity neutron sources, and for accumulation of large quantities of neutron-deficient isotopes. Estimates show the promise of each of these ideas. The results of the calculations are in good agreement with the known experimental data.

EXPLORATION

40342 (DP—1530) **Geology of the Birmingham, Gadsden, and Montgomery 1° x 2° NTMS quadrangles, Alabama.** Copeland, C.W.; Beg, M.A. (Alabama Geological Survey, University (USA)). Apr 1979. Contract EY-76-C-09-0001. 89p. Dep. NTIS, PC A05/MF A01.

This document is a facsimile edition (with accompanying maps) of geologic reports on the Birmingham, Gadsden, and Montgomery 1° x 2° NTMS quadrangles prepared for SRL by the Geological Survey of Alabama. Purpose of these reports is to provide background geologic information to aid in the interpretation of NURE geochemical reconnaissance data. Each report includes descriptions of economic mineral localities as well as a mineral locality map and a geologic map.

40343 (GJBX—48(79)(Vol.2)(DixonEntrance)) **NURE aerial gamma-ray and magnetic reconnaissance survey: southeastern area-Alaska, Dixon Entrance Quadrangle.** (LKB Resources, Inc., Huntingdon Valley, PA (USA)). Jan 1979. Contract EY-76-C-13-1664. 67p. Dep. NTIS, PC A04/MF A01.

Flight line profile data and statistical analysis results for the Dixon Entrance Quadrangle in southeast Alaska are presented. (LK)

40344 (GJBX—48(79)(Vol.2)(PortAlexander)) **NURE aerial gamma-ray and magnetic reconnaissance survey: southeastern area-Alaska, Port Alexander Quadrangle.** (LKB Resources, Inc., Huntingdon Valley, PA (USA)). Jan 1979. Contract EY-76-C-13-1664. 143p. Dep. NTIS, PC A07/MF A01.

The flight line profile data and statistical analysis results for the Port Alexander Quadrangle in southeast Alaska are presented.

40345 (GJBX—48(79)(Vol.2)(PrinceRupert)) **NURE aerial gamma-ray and magnetic reconnaissance survey: southeastern area-Alaska, Prince Rupert Quadrangle.** (LKB Resources, Inc., Huntingdon Valley, PA (USA)). Jan 1979. Contract EY-76-C-13-1664. 93p. Dep. NTIS, PC A05/MF A01.

The flight line profile data and statistical analysis results for the Prince Rupert Quadrangle in southeast Alaska are presented. (LK)

40346 (GJBX—48(79)(Vol.2)(TakuRiver)) **NURE aerial gamma-ray and magnetic reconnaissance survey: southeastern area-Alaska, Taku River Quadrangle.** (LKB Resources, Inc., Huntingdon

Valley, PA (USA)). Jan 1979. Contract EY-76-C-13-1664. 111p. Dep. NTIS, PC A06/MF A01.

Volume 2 presents the flight line profile data and statistical analysis results for the Taku River Quadrangle, southeast Alaska. (LK)

40347 (GJBX—49(79)(Vol.2)(Denver)) **Aerial gamma ray and magnetic survey: Rockies/Laramie Range Project, Denver Quadrangle, Colorado. Final report.** (GeoMetrics, Inc., Sunnyvale, CA (USA)). Feb 1979. Contract EY-76-C-13-1664. 484p. Dep. NTIS, PC A21/MF A01.

This volume contains the flight line profile data and statistical analysis results from the aerial gamma ray and magnetic survey of the Denver Quadrangle in Colorado.

40348 (GJBX—49(79)(Vol.2)(Pueblo)) **Aerial gamma ray and magnetic survey: Rockies/Laramie Range Project, Pueblo Quadrangle, Colorado. Final report.** (GeoMetrics, Inc., Sunnyvale, CA (USA)). Feb 1979. Contract EY-76-C-13-1664. 494p. Dep. NTIS, PC A21/MF A01.

Flight line profile data and statistical analysis results are presented for the Pueblo Quadrangle in Colorado.

40349 (GJBX—50(79)) **Engineering report on the drilling in the Upper Michigan Precambrian Basins.** (Michigan Dept. of Natural Resources, Lansing (USA). Geological Survey Div.). Apr 1979. Contract EY-76-C-13-1664. 81p. Dep. NTIS, PC E04/MF E01.

This project was in support of the DOE National Uranium Resource Evaluation (NURE) program. This project consisted of six holes, ranging in depth from 697 feet (212.45 m) to 3,176 feet (968.04 m). A total of 9,896 feet (3,016.3 m) were drilled, of which 8,654 feet (2,637.74 m) were cored. The project began in late September 1977 and continued into May 1978, with final site restoration and clean-up.

40350 (GJBX—59(79)(Vol.2)(Kingman)) **Airborne gamma-ray spectrometer and magnetometer survey: Kingman Quadrangle (Arizona, California, Nevada). Final report.** (Western Geophysical Co. of America, Houston, TX. Aero Service Div.). Feb 1979. Contract EY-76-C-13-1664. 428p. Dep. NTIS, PC A19/MF A01.

Volume 2 contains the flight line profile data and statistical results from the airborne gamma-ray spectrometer and magnetometer survey of the Kingman Quadrangle in Arizona, California, and Nevada.

40351 (GJBX—59(79)(Vol.2)(LasVegas)) **Airborne gamma-ray spectrometer and magnetometer survey: Las Vegas Quadrangle (Arizona, California, Nevada). Final report.** (Western Geophysical Co. of America, Houston, TX. Aero Service Div.). Feb 1979. Contract EY-76-C-13-1664. 244p. Dep. NTIS, PC A11/MF A01.

Volume 2 presents the flight line profile data and statistical analysis results for the Las Vegas Quadrangle in Arizona, California, Nevada.

40352 (GJBX—65(79)(Vol.1)) **Aerial radiometric and magnetic survey: Trona National Topographic Map, California.** (Geodata International, Inc., Dallas, TX (USA)). 11 Dec 1978. Contract EY-76-C-13-1664. 165p. Dep. NTIS, PC E13/MF E13.

The results of analyses of the airborne gamma radiation and total magnetic field survey flown for the region identified as the Trona National Topographic Map NI-11-12 is presented in Volume I and II of this report. The airborne data gathered is reduced by ground computer facilities to yield profile plots of the basic uranium, thorium and potassium equivalent gamma radiation intensities, ratios of these intensities, aircraft altitude above the earth's surface, total gamma ray and earth's magnetic field intensity, correlated as a function of geologic units. The distribution of data within each geologic unit, for all surveyed map lines and tie lines, has been calculated and is included. Two sets of profiled data for each line are included with one set displaying the above-cited data. The second set includes only flight line magnetic field, temperature, pressure, altitude data plus magnetic field data as measured at a base station. A general description of the area, including description of the area, including descriptions of the various geologic units and the corresponding airborne data is included also.

40353 (GJBX—65(79)(Vol.2)) **Aerial radiometric and magnetic survey: Trona National Topographic Map, California.** (Geodata International, Inc., Dallas, TX (USA)). 1979. Contract EY-76-C-13-1664. 149p. Dep. NTIS, PC A07/MF A01.

Flight line profile data and statistical analysis results are presented for the Trona National Topographic Map area of California.

40354 (GJBX—66(79)(Vol.2)) **Aerial radiometric and magnetic survey: Goldfield National Topographic Map, California and Nevada.** (Geodata International, Inc., Dallas, TX (USA)). 1979. Contract EY-76-C-13-1664. 151p. Dep. NTIS, PC A08/MF A01.

The flight line profile data and statistical analysis results from the aerial radiometric and magnetic survey of the Goldfield National Topographic Map area of California and Nevada.

40355 (GJBX—68(79)(Vol.1)) **Aerial radiometric and magnetic survey: Brownwood National Topographic Map, Texas.** (Geodata International, Inc., Dallas, TX (USA)). 26 Feb 1979. Contract EY-76-C-13-1664. 171p. Dep. NTIS, PC E09/MF E09.

The results of analyses of the airborne gamma radiation and total magnetic field survey flown for the region identified as the Brownwood National Topographic Map NH-14-2 is presented in Volume I and II of this report. The airborne data gathered are reduced by ground computer facilities to yield profile plots of the basic uranium, thorium and potassium equivalent gamma radiation intensities, ratios of these intensities, aircraft altitude above the earth's surface, total gamma ray and earth's magnetic field intensity, correlated as a function of geologic units. The distribution of data within each geologic unit, for all surveyed map lines and tie lines, has been calculated and is included. Two sets of profiled data for each line are included with one set displaying the above-cited data. The second set includes only flight line magnetic field, temperature, pressure, altitude data plus magnetic field data as measured at a base station. A general description of the area, including descriptions of the various geologic units and the corresponding airborne data, is included also.

40356 (GJBX—68(79)(Vol.2)) **Aerial radiometric and magnetic survey: Brownwood National Topographic Map, Texas.** (Geodata International, Inc., Dallas, TX (USA)). 1979. Contract EY-76-C-13-1664. 142p. Dep. NTIS, PC A07/MF A01.

Volume 2 contains the flight line profile data and statistical analysis results for the Brownwood Quadrangle in Texas. (LK)

MINING

REFER ALSO TO CITATION(S) 40408

FEED PROCESSING

40357 (NLCO—1153) **Techniques used to produce tonnage quantities of uranium alloys at the DOE's feed materials production center.** Schardt, R.L. (National Lead Co. of Ohio, Cincinnati (USA)). Apr 1979. Contract EY-76-C-05-1156. 21p. (CONF-790442—5). Dep. NTIS, PC A02/MF A01.

From International conference on metallurgical coatings; San Diego, CA, USA (23 Apr 1979).

The National Lead Company of Ohio (NLO) operates a large-scale integrated facility for the production of uranium ingots, fuel cores, and miscellaneous parts by chemical and metallurgical techniques. This paper describes the melting and casting equipment at NLO, shows how this equipment is used to produce dilute uranium alloys, and displays the various geometries cast within these facilities.

ENRICHMENT

LASER EXCITATION

40358 **Method of separating isotopes.** Niemann, H.J. (to Kraftwerk Union Aktiengesellschaft). US Patent 4,139,435. 13 Feb 1979. Priority date 18 Apr 1975, German, Federal Republic of (F.R. Germany), 6p.

A method is proposed for separating isotopes from a mixture of their respective gaseous compounds by means of laser radiation. The differences of the absorption coefficients at a given wavelength for the different isotopes which are to be separated should be as great as possible, so that only one isotope excited and may thus be isolated by conventional physical or chemical methods. Problems associated with finding spectral lines in the spectra of gaseous uranium compounds suitable for the attainment of good isotope separation are noted.

FUELS PRODUCTION AND PROPERTIES

REFER ALSO TO CITATION(S) 40357, 40454

40359 (INIS-mf—4322, pp 51-55) **Production of fast reactor dispersion fuel.** Benadik, A.; Urbanek, V.; Klimova, A. (Ustav Jaderneho Vyzkumu, Rez (Czechoslovakia)). Sep 1975. (In Czech).

From Sturture and properties of metals; Ostrava, Czechoslovakia (16 Sep 1975).

Gel spheres 3 mm in diameter were prepared by gelation of solutions of uranyl nitrate, urea and urotropin in a counter-current gelation column fed with silicon oil heated to a temperature of 90 degC. Two types of gel, designated as type B and type E, proved to be prospective. Particles of the B type were prepared from a solution of denitrated uranyl nitrate, urea and urotropin cooled to a temperature of -5 degC, and the E type particles were prepared from a solution of uranyl nitrate, urea and solid urotropin preserved at a temperature of 10 degC. The gel particles were washed in a washing column 60 mm in diameter with a perforated bottom using a 2.5% solution of ammonia. The following washing regime was determined as being optimal: temperature of washing solution 40 degC, flow rate 15 l/h, washing time 40 mins. In the process of particle drying it was ascertained that B type gel particles withstand higher differences in the concentrations of the volatile components in the drying atmosphere and on the surface of the dried particles, and higher temperature gradients. E type particles crack under these conditions. These conditions were best met in drying by organic liquid vapours (carbon tetrachloride).

40360 (ORNL—5510) **Irradiation performance of HTGR fuel in HFIR capsule HT-31.** Tiegs, T.N.; Robbins, J.M.; Hamner, R.L.; Montgomery, B.H.; Kania, M.J.; Lindemer, T.B.; Morgan, C.S. (Oak Ridge National Lab., TN (USA)). May 1979. Contract W-7405-ENG-26. 63p. Dep. NTIS, PC A04/MF A01.

The capsule was irradiated in the High Flux Isotope Reactor at ORNL to peak particle temperatures up to 1600°C, fast neutron fluences (0.18 MeV) up to 9 x 10^{25} n/m^2, and burnups up to 8.9% FIMA for ThO_2 particles. The oxygen release from plutonium fissions was less than calculated, possibly because of the solid solution of SrO and rare earth oxides in UO_2. Tentative results show that pyrocarbon permeability decreases with increasing fast neutron fluence. Fission products in sol-gel UO_2 particles containing natural uranium mostly behaved similarly to those in particles containing highly enriched uranium (HEU). Thus, much of the data base collected on HEU fuel can be applied to low-enriched fuel. Fission product palladium penetrated into the SiC on Triso-coated particles. Also the SiC coating provided some retention of /sup 110m/Ag. Irradiation above about 1200°C without an outer pyrocarbon coating degraded the SiC coating on Triso-coated particles.

40361 (WAPD-TM—1394) **Iodine and cesium in oxide fuel pellets and zircaloy-4 cladding of irradiated fuel rods (LWBR Development Program).** Ivak, D.M.; Waldman, L.A. (Bettis Atomic Power Lab., West Mifflin, PA (USA)). Mar 1979. Contract EY-76-C-11-0014. 54p. Dep. NTIS, PC A04/MF A01.

Measurements of fission product iodine and cesium are reported for thoria and binary (ThO_2—UO_2) fuels with various irradiation histories. These volatile fission products were measured on the cladding surface or in the fuel by using specially developed radiochemical techniques. The radiochemical iodine measurements are found to be in general agreement with a theoretical iodine release model for irradiated fuel. Microprobe examinations of irradiated fuel rod cladding sections show fission product cesium to be located preferentially at the pellet to pellet interface region. Fission product iodine was detected in the interface region of one sample but generally remained below the microprobe limit of detection. 18 figures, 7 tables.

40362 (WCAP—9359) **Research and development program for selected components of mixed oxide fuel fabrication. Quarterly progress report for period ending March 31, 1978.** Limpert, J.C. (comp.). (Westinghouse Electric Corp., Pittsburgh, PA (USA). Nuclear Fuel Div.). 1978. Contract EN-77-C-06-1058-001. 60p. Dep. NTIS, PC A04/MF A01.

The status of four task studies is reported: pneumatic transport system development; powder batch weighing system; residual material holdup and powder release; and barrier seal development. Construction of the pneumatic transport test system at the Westinghouse Research Center was completed, and all instrumentation was calibrated. Functional and mechanical debugging and base line tests were completed. The 2-in. loop system was readied for introduction of depleted urania power for performance evaluation testing. A nuclear safety study was conducted to determine the impact on equipment arrangement of the change to $(U,Pu)O_2$ COMOX feed material. The investigation revealed that the cylindrical hopper height and overall equipment stack-up height becomes prohibitive, in excess of 20 ft for 10 w/o PuO_2—UO_2 COMOX material, at safe hopper diameters. An alternative safe slab geometry was evaluated for COMOX material and the resulting design height was reduced to less than 11 ft. Based on this study, the system design was revised to use safe slab geometry for the COMOX element of the powder batching system. The scrap and UO_2 hoppers remain cylindrical. All milestones on the residual material holdup and powder release task are completed and reporting of the results is essentially accomplished. Five barrier seal concepts were defined in detailed design layout drawings. To enable the test seal selection from the five designs, a design data package was assembled and used by a review committee as a guideline for the selection of a seal concept which would have the highest probability of success in meeting the specified design objectives. An engineering evaluation of each seal concept was made using a design decision matrix for scoring each seal under seven different categories. The seal concept selected was typically a sphincteral seal with an open, two-dimensional venturi and boundary layer control.

40363 (WCAP—9387) **Research and development program for selected components of mixed oxide fuel fabrication. Quarterly progress report for period ending June 30, 1978.** Limpert, J.C. (comp.). (Westinghouse Electric Corp., Pittsburgh, PA (USA). Nuclear Energy Systems Div.). 1978. Contract EN-77-C-06-1058-001. 79p. Dep. NTIS, PC A05/MF A01.

In the pneumatic powder transport system development task, the conversion of thorium—uranium nitrate solution to nominal 20% ThO_2—80% UO_2 master mix powder was completed. Physical characteristics of specific surface area, average particle size, O/M ratio, moisture, and bulk density were within target specifications, based on samples from selected batches. Shakedown tests of a powder transport system that had been built at Westinghouse Research and Development Center were completed in late May. Three test series of a test program were completed and the data analyzed. It was learned from test series 1, where dry-process-derived urania powder was used, that a single batch of this powder could be used for only approximately five runs (transported about 1,100 feet) before its flow properties began to change. Although it will have no effect on plant design, this phenomenon is being further investigated. The detail design phase of the powder batch weighing system was completed by Toledo Scale Company and a design package was submitted to Westinghouse for review and approval. The detail design was reviewed by Westinghouse relative to conformance to the functional requirements for a powder batching system in a large-scale mixed oxide fuel fabrication plant. The Toledo Scale Company design was approved with minor comments, releasing the system for fabrication. The barrier seal design data package (5 seal designs) was presented to DOE; the design selected was a sphincteral seal with an open two-dimensional venture. Detailed drawings of the seal and test system were prepared and issued to fabricators for quotations. Fabrication of the test system is about 90% complete.

SPENT FUELS REPROCESSING

REFER ALSO TO CITATION(S) 40403, 40404, 40405, 40406, 40409, 40411, 40412, 40413, 40414, 40448, 40457, 40461, 40464, 40467

40364 (CONF-780819—P1, pp 477-493) **Burner and dissolver off-gas treatment in HTR fuel reprocessing.** Barnert-Wiemer, H.; Heidendael, M.; Kirchner, H.; Merz, E.; Schroeder, G.; Vygen, H. (Kernforschungsanlage Juelich GmbH, Germany). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

In the reprocessing of HTR fuel, essentially all of the gaseous fission products are released during the heat-end tratment, which includes burning of the graphite matrix and dissolving of the heavy metallic residues in THOREX reagent. Three facilities for off-gas cleaning are described, the status of the facility development and test results are reported. Hot tests with a continuous dissolver for HTR-type fuel (throughput 2 kg HM/d) with a closed helium purge loop have been carried out. Preliminary results of these experiments are reported.

40365 (CONF-780819—P1, pp 494-511) **Aerosol and iodine removal system for the dissolver off-gas in a large fuel reprocessing plant.** Furrer, J.; Wilhelm, J.G.; Jannakos, K. (Kernforschungsanlage Juelich GmbH, Germany). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

A newly developed filter combination for the dissolver off-gas in a reprocessing plant with a throughput of 1400 t/y of heavy metal is presented and single filter components are described. The design principle chosen provides for remote handling and direct disposal in waste drums of 200 l volume. The optimization of housings and filter units is studied on true scale components in the simulated dissolver off-gas of a test facility named PASSAT. This facility will be described. PASSAT will be also used for final testing of the SORPTEX process which is under development. Its concept is included in the paper. The design and function of the new multiway sorption filter providing for complete loading of the iodine sorption material and maintaining continuously high decontamznation factors will also be given. Removal efficiencies measured for aerosols and iodine in an existing reprocessing plant are indicated.

40366 (CONF-780819—P1, pp 600-613) **Review of some UKAEA work on gas cleaning in fuel reprocessing plant.** Elliot, M.N. (UDAEA, Harwell, England); Lilleyman, E. Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

The efficiency of air cleaning systems for fuel reprocessing plant is of prime importance and present systems based upon HEPA filtration have proved very satisfactory in this respect. However, with the larger installations the associated handling and storage procedures are less attractive and new approaches are being developed for the changing levels of radioactivity and plant throughput. An interim report of the work is presented. Improvements can be obtained from a reduction in the size or number of filter installations, an increase in filter life, and from simpler handling and storage procedures. Alternative schemes which can reduce the ventilation load or the number of separate filter installations are discussed. Prefiltration techniques can extend filter life and work on a condensation technique and electrostatic precipitation is described. Methods of volume reduction for storage or disposal of spent filters (by compaction, dismantling and incineration) are being examined and progress to date is reported. Filter sealing and change mechanisms vary with application and have some features in common with more conventional posting systems. Techniques in use or being considered for α and $\beta\gamma$ -active applications are discussed.

40367 (ICP—1168) **Second electrolytic dissolution campaign of EBR-II fuel at ICPP.** Mortimer, S.R. (Allied Chemical Corp., Idaho Falls, ID (USA). Idaho Chemical Programs - Operations Office). Dec 1978. Contract EY-76-C-07-1540. 35p. Dep. NTIS, PC A03/MF A01.

The second fuel reprocessing campaign using the electrolytic dissolution facility at the Idaho Chemical Processing Plant (ICPP) took place from February 1975 to November 1976. Several forms of EBR-II fuel, and various scrap fuels containing highly-enriched uranium, were dissolved in nitric acid in the dissolver's electric field. Gadolinium was used as a soluble nuclear poison to guarantee nuclear safety in the headend processing equipment. 9 figures, 5 tables.

40368 (LA-UR—79-1020) **Quick and accurate profile monitor for irradiated fuel.** Lee, D.M.; Phillips, J.R.; Hsue, S.T.; Kaieda, K.; Halbig, J.K.; Medina, E.G.; Hatcher, C.R. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 8p. (CONF-790430—6). Dep. NTIS, PC A02/MF A01.

From 1. annual symposium on safeguards and nuclear material management; Brussels, Belgium (25 Apr 1979).

Portions of this document are illegible.

A new instrument has been developed for the rapid measurement of the activity profile of irradiated fuel pins and assemblies. Through prototype examinations it has been shown that the profile shapes agree with the shapes as measured by an intrinsic germanium detector and a Be(γ,n) detector. This new technique can reduce the profile measurement time by more than an order of magnitude over existing measurement times.

40369 (M—78-68(Vol.3), pp 254-267) **Fluidized combustion of beds of large, dense particles in reprocessing HTGR fuel.** Young, D.T. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Fluidized bed combustion of graphite fuel elements and carbon external to fuel particles is required in reprocessing high-temperature gas-cooled reactor (HTGR) cores for recovery of uranium. This burning process requires combustion of beds containing both large particles and very dense particles as well as combustion of fine graphite particles which elutriate from the bed. Equipment must be designed for optimum simplicity and reliability as ultimate operation will occur in a limited access 'hot cell' environment. Results reported in this paper indicate that successful long-term operation of fuel element burning with complete combustion of all graphite fines leading to a fuel particle product containing $< 1\%$ external carbon can be performed on equipment developed in this program.

40370 (ORNL—5471) **SEPHIS-MOD4: a user's manual to a revised model of the Purex solvent extraction system.** Mitchell, A.D. (Oak Ridge National Lab., TN (USA)). May 1979. Contract W-7405-ENG-26. 79p. AT.

The SEPHIS computer program is a tool for simulating the operation of mixer-settlers in the solvent extraction portions of the Purex process. SEPHIS-MOD4 is a new and significantly improved version of the SEPHIS program. This report gives a detailed description of how the solvent extraction system is being simulated so that the user can more fully understand the results of the program. Although it is not necessary to run the program, an explanation of the program's mechanics is given to help remove the mystery which usually surrounds computer codes. Due to the finite nature of computers, several approximations and assumptions were made to simplify the system so that a computer can easily handle the process. A description of these approximations is given to help the user of the program understand why differences are found between the predicted and experimental concentrations in a system. In order to run the program, a description of the input cards and some examples are given. SEPHIS-MOD4 is more flexible than the previous versions of SEPHIS; thus, familiarity with some of the variables is helpful in limiting the output to only the desired results. A listing of the computer code is given in the appendices.

40371 (ORNL/CSD/TM—69) **Modeling the effect of temperature on thorium and nitric acid extraction and the formation of third phase for modification of the SEPHIS: Thorex computer program.** Watson, S.B.; Rainey, R.H. (Oak Ridge National Lab., TN (USA)). May 1979. Contract W-7405-ENG-26. 35p. AT.

Mathematical models have been developed for use with the SEPHIS - Thorex code which correct for the effect of temperature on thorium and nitric acid extraction and which provide a signal to indicate the formation of a second organic phase. Experimental programs have provided data which have been analyzed and indicate that increasing temperature decreases the distribution coefficient of thorium. Also increasing the temperature increases the concentration of thorium in the organic phase at which the third phase is formed. 14 figures, 3 tables.

40372 (ORNL/CSD/TM—70) **User's guide to the SEPHIS computer code for calculating the Thorex solvent extraction system.** Watson, S.B.; Rainey, R.H. (Oak Ridge National Lab., TN (USA)). May 1979. Contract W-7405-ENG-26. 50p. AT.

The SEPHIS computer program was developed to simulate the countercurrent solvent extraction process. The code has now been adapted to model the Acid Thorex flow sheet. This report represents a practical user's guide to SEPHIS - Thorex containing a program description, user information, program listing, and sample input and output.

40373 (ORNL/TM—6643) **Voloxidation and dissolution of irradiated (Th,U)O_2.** Goode, J.H.; Stacy, R.G. (Oak Ridge National Lab., TN (USA)). Apr 1979. Contract W-7405-ENG-26. 25p. AT.

Exploratory hot-cell tests were made to determine the amounts of fission products released by high-temperature oxidation (voloxidation) of irradiated fuel, initially $(Th_{0.96}U_{0.04})O_2$, and whether the treatment would affect the subsequent dissolution of the oxide. Fifteen-year-decayed fuel rods were sheared to dislodge the (Th,U)O_2 from its cladding, sieved to determine the size range, and an aliquot was oxidized in flowing air at 600°C for $\sim$ 2 h while tumbling at 12 rpm. The voloxidation released only 0.2% of the ^{85}Kr and 6% of the ^{3}H contained in the (Th,U)O_2. The oxidized and unoxidized portions were leached three times in a 95°C Thorex reagent to dissolve the fuel. The voloxidation apparently had no effect on the dissolution of the mixed oxide. The presence of cladding slowed the dissolution by limiting the amount of fuel exposed to the acid.

40374 (ORNL/TM—6786) **Interphase transfer kinetics of uranium using the drop method, Lewis cell, and Kenics mixer.** Horner, D.E.; Mailen, J.C.; Thiel, S.W.; Scott, T.C.; Yates, R.G. (Oak Ridge National Lab., TN (USA)). May 1979. Contract W-7405-ENG-26. 31p. Dep. NTIS, PC A03/MF A01.

The rate constants for the interphase transfer of uranium between 3.5 M HNO_3 and tributyl phosphate (TBP) - normal hydrocarbon diluent solutions have been measured using the single drop method, Lewis cell method, and a Kenics mixer - centrifugal separator. Rate constants obtained by all methods were the same within experimental error. The variables studied that affect the rate constants include the TBP concentration, the acidity and total neutral nitrate concentrations of the aqueous phase, and temperature. Results of these tests indicate that the rate controlling mechanism is chemical reaction at the interface.

40375 **Method for selectively reducing plutonium values by a photochemical process.** Friedman, H.A.; Toth, L.M.; Bell, J.T. (to Dept. of Energy). US Patent 4,131,527. 26 Dec 1978. Filed date 30 Mar 1977. 8p.

The rate of reduction of Pu(IV) to Pu(III) in nitric acid solution containing a reducing agent is enhanced by exposing the solution to 200—500 nm electromegnetic radiation. Pu values are recovered from an organic extractant solution containing Pu(IV) values and U(VI) values by the method of contacting the extractant solution with an aqueous nitric acid solution in the presence of a reducing agent and exposing the aqueous solution to electromagnetic radiaion having a wavelength of 200—500 nm. Under these conditions, Pu values preferentially distribute to the aqueous phase and U values preferentially distribute to the organic phase.

40376 **BNFL gets going again on THORP.** Masters, R. *Nucl. Eng. Int.;* **23**: No. 273, 29-31(Jul 1978).

British Nuclear Fuels development programme for the Thermal Oxide Reprocessing Plant, THORP, at Windscale is now continuing, following the delay caused by the public inquiry. The plant is an evolution of the existing Magnox reprocessing plant. Some of the major differences are outlined. Testing in full-scale rigs and a fully active pilot plant form part of the programme. The construction schedule is outlined.

40377 **Civex. The answer to nuclear blackmail.** *Nucl. Eng. Int.;* **23**: No. 273, 59-60(Jul 1978).

A method is proposed for reprocessing fast breeder reactor fuel in a proliferation-proof way. To prevent diversion of Pu it is necessary that there should be no pure Pu in storage, none produced at any intermediate stage, and no way of producing it without equipment modifications which could not be performed with normal site facilities. There should moreover be no way of carrying out modifications to the equipment without its decontamination or without involving entry into areas of extremely high radiation. The chemistry of the Civex process, which it is claimed would achieve these aims, and the layout of the plant, are both described.

40378 **Catalytic effect of fission products on the low temperature fluorination of uranium oxide with elemental fluorine.** Maeda, M.; Yagi, E. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *Inorg. Nucl. Chem. Lett.;* **14**: No. 10, 341-345(1978).

Fluorination of uranium oxides with elemental fluorine has practical significance as a basic reaction in the fluoride volatility process, an advanced non-aqueous reprocessing process. In this letter a report is presented on a marked enhancing effect on fluorination rate by small quantities of non-volatile elements added to uranium oxide powder as simulated fission products. This effect would be of interest for the possible application to the catalytic conversion of uranium oxides at temperatures below 300°C and as a new example of the unusual topochemical effect in fluorination.

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 40481

40379 (DOE/ET—0075) **Spent fuel storage requirements: the need for away-from-reactor storage.** (Department of Energy, Washington, DC (USA). Div. of Spent Fuel Storage and Transfer). Feb 1979. 52p. Dep. NTIS, PC A04/MF A01.

The projected AFR requirements which have been developed represent data as of December 31, 1978 on at reactor fuel pool expansion plans. The base case, which was identified for purposes of sensitivity analysis, assumes transshipments between reactor basins within the same utility. It is very likely that transshipment will not be utilized for all reactors. Hence the base case AFR requirements discussed in this report represent a minimum or lower bound for purposes of planning. If some assumptions are varied, a wide range of AFR requirements results. The smaller the amount of fuel shipped to other reactor basins within the utilities' systems, the greater are the AFR requirements. It is also possible that some utilities may be able to expand their reactor spent fuel pools beyond the base case data. On the other hand, some utilities may not be able to expand as much as currently planned because of licensing, engineering, or institutional problems. Clearly, a number of factors exist which can influence AFR requirements.

40380 (INIS-mf—4472) **Prospects of spent management in Spain.** Melches, C.; Ramirez, E.; Selgas, F. (Empresa Nacional del Uranio, Madrid (Spain)); Cabanilles, P.A.; Lopez Perez, B.; Uriarte, A. (Empresa Nacional del Uranio, Madrid (Spain); Junta de Energia Nuclear, Madrid (Spain)). 1978. 10p. (CONF-780658—17). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Seminar on the storage of spent fuel elements; Madrid, Spain (Jun 1978).

The purpose of this paper is to outline the forecast on spent fuel management in Spain, taking into account the international developments produced during the last years and specially on LWR fuels. This forecast is based on the following actions: increase of the storage capacity in the reactors: construction of an independent spent fuel storage installation (ISFSI) and a fuel reprocessing pilot plant.

40381 (INIS-mf—4473) **Neutron analysis of spent fuel pools.** Pereyra, J. (Instituto Peruano de Energia Nuclear, Lima); Caro, R.; Cano, J.M.; Donoso, E.; Esteban, A.; Martinez-Val, J.M. (Instituto Peruano de Energia Nuclear, Lima; Junta de Energia Nuclear, Madrid (Spain)). 1978. 6p. (CONF-780658—19). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Seminar on the storage of spent fuel elements; Madrid, Spain (Jun 1978).

The nuclear energy industry in Spain, as everywhere in the world, is facing the problem of increasing the capacity of the existing pools for storing spent fuel elements. At JEN the problems related with this circumstance are being analyzed. In this work part of the corresponding research is included and it is expected to publish in the very near future a more detailed comprehensive work including neutronics, thermohydraulic and shielding aspects of the spent fuel pool design.

40382 (INIS-mf—4474) **Expansion of capacity of spent fuel pools and associated problems.** De Francisco, J.L.; Lopez-Cotarelo, J.; Ramos, J.M. (SEE CODE- 5691700 SENER, Tecnica Industrial y Naval, Bilbao (Spain)). 1978. 13p. (CONF-780658—16). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Seminar on the storage of spent fuel elements; Madrid, Spain (Jun 1978).

Expanding the spent fuel storage pool capacity is a good solution for utilities facing the current shortage in fuel reprocessing capacity. The problems more likely to be found when expanding a spent fuel storage facility by using high density storage racks are reviewed. Basically three types of problems arise: 1) Problems related with the characteristics of the new facility. 2) Problems related with the works of expansion. 3) Problems related with the long term storage of large quantities of spent fuel.

40383 (INIS-mf—4475) **Cost and implications of a middle-term program for storage of spent fuel in a nuclear power station (BWR).** Mochon, J.L.; Quintana, R. (Hidroelectrica Espanola, Madrid). 1978. 7p. (CONF-780658—18). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Seminar on the storage of spent fuel elements; Madrid, Spain (Jun 1978).

The experience gained with the Cofrentes Nuclear Power Station Project is presented. Originally the station had two spent fuel storage pools, in the fuel building, plus a little pool inside the containment, and all were to be fitted with extensive aluminium storage racks with a total capacity for 1+-1/3 cores. Due to the present world situation with regard to the "back-end"of the fuel cycle, it was decided to enlarge the pools size and to change the design of the racks, to obtain a final storage capacity of 5+-1/4 cores, so covering over 18 years of operation. The changes introduced in the project, as well as its costs, and the possibilities of election still open are examined in the paper.

40384 (INIS-mf—4483) **Evaluation of the problems associated with ENEL's irradiated fuel management.** Sani, L.; Belelli, U. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). 1978. 8p. (CONF-780658—20). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Seminar on the storage of spent fuel elements; Madrid, Spain (Jun 1978).

The present difficulties in the reprocessing field, wich will continue for a period of time not easily definable, impose on the nuclear utilities the research of adequate solutions to solve the problem associated with storage of the fuels discharged by the nuclear power stations in operation. In this context, the paper examines the technical aspects of the various possible alternatives and on the basis of the Italian nuclear program, possible storage strategies are discussed on the assumption of the development of an adequate oxide-fuel reprocessing capacity. The problems related to storage in pools at the station or away from reactor are described in the light of the recent experience made in Italy with the adaptation of an old pool reactor out of service, that is, the Avogadro reactor in Saluggia, to store the fuels of the stations now in operation. Finally some economic aspects are considered in order to ascertain their impact on the cost of energy produced.

40385 **Spent nuclear fuel storage racks.** Mollon, L. (to Brooks and Perkins, Inc.). US Patent 4,143,276. 6 Mar 1979. Filed date 9 May 1977. 6p.

A storage rack in which a plurality of tubular shrouds are assembled together in a checkerboard arrangement, each shroud having side walls arranged to absorb sub-atomic particles such as neutrons. With this arrangement, spent atomic fuel rods may be assembled in the shrouds and also in the spaces which are surrounded by shrouds, so that each adjacent grouping of fuel rods has interposed therebetween an emission absorbing wall.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 40380, 40449, 40455

40386 (ADL-C—1065-1) **Evaluation of alternatives for defense waste management at the Savannah River Plant: Phase I report.** (Little (Arthur D.), Inc., Cambridge, MA (USA)). 1 Aug 1978. Contract EW-78-C-09-1065. 57p. Dep. NTIS, PC A04/MF A01.

Work has led to the selection by DOE and its contractors of candidate processes for treatment of high-level defense wastes for ultimate disposal. The work at Savannah River has progressed to the point where a reference process has been selected and a research program implemented to develop that process. In May 1978, SRO contracted with Arthur D. Little, Inc., to perform an independent evaluation of the SRO defense waste management program in the context of a national program including the Hanford, Idaho and West Valley, New York, sites. This study was to be performed in two parts, as follows: Phase I: Review of the alternatives for long-term defense waste processing and selection of an alternative for implementation at Savannah River. Phase II: Evaluation of the selected alternative in detail and an assessment of the elements of the effort for implementation. The Phase I study was proposed to be a rapid evaluation, with a brief written report to be completed in August 1978. This report constitutes the fulfillment of that portion of the contract.

40387 (CONF-780819—P1, pp 4-7) **Nuclear waste management at DOE.** Perge, A.F. (Department of Energy, Washington, DC). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

DOE is responsible for interim storage for some radioactive wastes and for the disposal for most of them. Of the wastes that have to be managed a significant part are a result of treatment systems and devices for cleaning gases. The long term waste management objectives place minimal reliance on surveillance and maintenance. Thus, the concerns about the chemical, thermal, and radiolytic degradation of wastes require technology for converting the wastes to forms acceptable for long term isolation. The strategy of the DOE airborne radioactive waste management program is to increase the service life and reliability of filters; to reduce filter wastes; and in anticipation of regulatory actions that would require further reductions in airborne radioactive releases from defense program facilities, to develop improved technology for additional collection, fixation, and long-term management of gaseous wastes. Available technology and practices are adequate to meet current health and safety standards. The program is aimed primarily at cost effective improvements, quality assurance, and the addition of new capability in areas where more restrictive standards seem likely to apply in the future.

40388 (DOE/ET—0094) **Nuclear waste management program. Summary document.** (Department of Energy, Washington, DC (USA). Office of Nuclear Waste Management). Apr 1979. 249p. Dep. NTIS, PC A11/MF A01.

This document outlines the operational and research and development (R & D) activities of the Office of Nuclear Waste Management (ETW) under the Assistant Secretary for Energy Technology, DOE. The national energy policy as it applies to waste management and spent fuel storage is presented first. The program strategy, structure, budget, management approach, and public participation programs are then identified. The next section describes program activities and outlines their status. Finally, the applicability of departmental policies to ETW programs is summarized, including field and regional activities, commercialization plans, the environmental and socioeconomic implications of waste management activities, and international programs.

40389 (INIS-mf—4627) **Legal, administrative and financial aspects of long term management of radioactive waste.** Strohl, P. (Nuclear Energy Agency, 75 - Paris (France)). 1978. 14p. (CONF-780584—10). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on regulating nuclear energy; Brussels, Belgium (16 May 1978).

Radioactive waste management raises technical, political and legal problems. The technical question covers mainly choice of the method and the location for waste disposal or storage: seabed, geologic formations or a disposal facility. The political problem is mainly acceptability by the public of decisions taken or planned by the competent authority. Finally, the legal frame is an important factor in the definition of long-term control. The institutional system to be created requires political consensus and an efficient and credible technique so as to be successful.

40390 (PNL—2751) **Compatibility of two Idaho Chemical Processing Plant glasses with electric melting processes.** Lukacs, J.M.; Bates, J.L.; Devine, J.R.; Gray, W.J.; Weber, W.J. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Dec 1978. Contract EY-76-C-06-1830. 49p. Dep. NTIS, PC A03/MF A01.

High-level liquid nuclear wastes produced at the Idaho Chemical Processing Plant (ICPP) was converted to a dry calcine powder. The feasibility of converting this calcine to a durable waste glass is being evaluated at ICPP. Candidate waste glass compositions were developed and plans were made to construct and operate a laboratory electric glass melter at INEL. The Pacific Northwest Laboratory (PNL) examined the electric melter processing characteristics of two Idaho developed waste glasses, ICPP Zr-13 and ICPP Zr-51. This preliminary evaluation found both borosilicate glasses acceptable candidates for electric melting trials. The high temperature resistivity, viscosity, and corrosion behaviors are consistent with PNL melting experience. The ICPP calcine characteristics, waste glass volatility, and waste glass devitrification behavior have not been previously encountered at PNL. Several melter operation and design options are available to deal with all of these conditions. Additional work in three basic areas is, however, suggested for the final candidate waste glass composition: volatility - species identification; corrosion behavior of electrodes at operating temperatures; and means of improving melting rates and glass homogeneity. Reducing the devitrification tendency of the candidate waste glass will significantly improve the stability and control of an electric glass melting process.

40391 (RHO-SA—107) **Quality assurance in alternative energy sources.** Hammond, R.D. (Atomics International Div., Richland, WA (USA). Rockwell Hanford Operations). 2 Feb 1979. Contract EY-77-C-06-1030. 14p. Dep. NTIS, PC A02/MF A01.

In July 1977, Rockwell assumed the Operating Contractor responsibilities at Hanford for the Department of Energy, Richland Operations Office. This paper reflects on the Hanford history, describes the radwaste efforts now taking place, outlines future plans and highlights the increasing role of Quality Assurance.

40392 (UCRL—81661(Rev.2)) **Methodology for estimating accidental radioactive releases in nuclear waste management.** Levy, H.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 17 Jan 1979. Contract W-7405-ENG-48. 8p. (CONF-781121—24). Dep. NTIS, PC A02/MF A01.

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

Estimation of the risks of accidental radioactive releases is necessary in assessing the safety of any nuclear waste management system. The case of a radioactive waste form enclosed in a barrier system is considered. Two test calculations were carried out. (DLC)

40393 **Ceramic forms for nuclear waste.** Dosch, R.G. (Sandia Labs., Albuquerque, NM). pp 129-148 of Radioactive waste in geologic storage. Fried, S. (ed.). Washington, DC; American Chemical Society (1979).

From American Chemical Society meeting; Miami, FL, USA (10 Sep 1978).

The baseline solidification process used an inorganic titanate ion exchange material in a downflow, fixed-bed column. The loaded material is dried and pressure sintered at 900 to 1100°C. The baseline process was demonstrated using both simulated high-level waste and spent LWR fuel waste. A batch procedure using magnesium titanate rather than sodium titanate was also tested. The structure and composition of the baseline product were stuied; its leaching characteristics were compared with those of vitrified waste. Both the ceramic and glass wastes were resistant to leaching at 95°C, but were leached at 250°C. Stability of the ceramic waste form is superior to vitrified wastes in the leaching studies at high temperatures. 26 references, 2 figures, 4 tables. (DLC)

40394 **Can nuclear power be accepted today in the light of the waste management problem.** Schueller, W. (Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen m.b.H., Eggenstein-Leopoldshafen (Germany, F.R.)). *Atomwirtsch., Atomtech.;* 23: No. 7, 326-334(1978). (In German).

From Reactor congress; Hannover, Germany, F.R. (4 - 7 Apr 1978).

The waste management problem occupies a central position in the public debate about nuclear power. Even many proponents of this source of power share the concern that the seemingly unsolved problems associated with the disposal of radioactive waste might lead into a technological blind alley. The nuclear fuel cycle, including plutonium reycling in light water reactors, has been practised in the Federal Republic on a technical scale for many years. The three demonstration plants used for this purpose, i.e., KWO, WAK and ALKEM, represent an aggregate capital investment of some DM 830 million and have a staff of at present approximately 900 persons. More than 24 years of experience on a technical scale is available for the Purex process used for reprocessing. The experience of German industry in reprocessing high-burnup oxide LWR fuel elements is based on the operation of two experimental facilities over a period of twelve years, almost seven years of which are for the WAK, which successfully reprocessed fuel elements with burnups as high as 39.000 MWd/t of uranium. The article specifically discusses the doubts frequently expressed about the extrapolability of operating experience accumulated in processing low-burnup fuels to fuel with high burnup, i.e., from the Karlsruhe experimental scale facility to the large scale plant of the waste management center. The objections often raised against the planned upscaling of plant throughputs when moving to industrial scale processes do not take into account that the decisive operating experience generated in the technical radioche-

mistry is hardly a function of material throughputs, but rather refers to the specialized techniques employed in handling radioactive and fissile materials.

WASTE PROCESSING

REFER ALSO TO CITATION(S) 40364, 40365, 40366, 40448

40395 (CONF-780819—P1) **Proceedings of the fifteenth DOE nuclear air cleaning conference.** First, M.W. (ed.). (Department of Energy, Washington, DC (USA); Harvard Univ., Boston, MA (USA). Harvard Air Cleaning Lab.). Feb 1979. 638p. Dep. NTIS, PC A99/MF A01.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Papers presented are grouped under the following topics: air cleaning; waste volume reduction and preparation for storage; tritium, carbon-14, ozone; containment of accidental releases; adsorbents and absorbents; and off-gas treatment. A separate abstract was prepared for each paper.

40396 (CONF-780819—P1, pp 70-81) **Operation of low-level radioactive waste incinerator.** Choi, E.C.; Drolet, T.S.; Stewart, W.B.; Campbell, A.V. (Ontario Hydro, Toronto, Canada). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Ontaro Hydro's radioactive waste incinerator designed to reduce the volume of low-level combustible wastes from nuclear generating station's was declared in-service in September 1977. Hiterto about 1500 m^3 of combustible waste have been processed in over 90 separate batches. The process has resulted in 40:1 reduction in the volume and 12.5:1 reduction in the weight of the Type 1 wastes. The ultimate volume reduction factor after storage is 23:1. Airborne emissions has been maintained at the order of 10^{-3} to 10^{-5}% of the Derived Emission Limits. Incineration of radioactive combustible wastes has been proven feasible, and will remain as one of the most important processes in Ontario Hydro's Radioactive Waste Management Program.

40397 (CONF-780819—P1, pp 82-94) **Fluidized-bed calcination of LWR fuel-reprocessing HLLW: requirements and potential for off-gas cleanup.** Schindler, R.E. (Allied Chemical Corp., Idaho Falls, ID). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Fluidized-bed solidification (calcination) was developed on a pilot scale for a variety of simulated LWR high-level liquid-waste (HLLW) and blended high-level and intermediate-level liquid-waste (ILLW) compositions. It has also been demonstrated with ICPP fuel-reprocessing waste since 1963 in the Waste Calcining Facility (WCF) at gross feed rates of 5 to 12 m^3/day. A fluidized-bed calciner produces a relatively large volume of off-gas. A calciner solidifying 6 m^3/day of liquid waste would generate about 13 standard m^3/min of off-gas containing 10 to 20 g of entrained solids per standard m^3 of off-gas. Use of an off-gas system similar to that of the WCF could provide an overall process decontamination factor for particulates of about 2×10^{10}. A potential advantage of fluidized-bed calcination over other solidification methods is the ability to control ruthenium volatilization from the calciner at less than 0.01% by calcining at 500°C or above. Use of an off-gas system similar to that of the WCF would provide an overall process decontamination factor for volatile ruthenium of greater than 1.6×10^7.

40398 (CONF-780819—P1, pp 95-110) **Volatilization from borosilicate glass melts of simulated Savannah River Plant waste.** Wilds, G.W. (E.I. du Pont de Nemours & Co., Aiken, SC). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Laboratory scale studies determined the rates at which the semivolatile components sodium, boron, lithium, cesium, and ruthenium volatilized from borosilicate glass melts that contained simulated Savannah River Plant waste sludge. Sodium and boric oxides volatilize as the thermally stable compound sodium metaborate, and accounted for ~ 90% of the semivolatiles that evolved. The amounts of semivolatiles that evolved increased linearly with the logarithm of the sodium content of the glass-forming mixture. Cesium volatility was slightly suppressed when titanium dioxide was added to the melt, but was unaffected when cesium was added to the melt as a cesium-loaded zeolite rather than as a cesium carbonate solution. Volatility of ruthenium was not suppressed when the glass melt was blanketed with a nonoxidizing atmosphere. Trace quantities of mercury were removed from vapor streams by adsorption onto a silver-exchanged zeolite. A bed containing silver in the ionic state removed more than 99.9% of the mercury and had a high chemisorption capacity. Beds of lead-, copper-, and copper sulfide-exchanged zeolite-X and also an unexchanged zeolite-X were tested. None of these latter beds had high removal efficiency and high chemisorption capacity.

40399 (CONF-780819—P1, pp 313-334) **Non-radioactive determination of the penetration of methyl iodide through impregnated charcoals during dosing and purging.** Romans, J.B.; Deitz, V.R. (Naval Research Lab., Washington, DC). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

A laboratory procedure is described using methyl iodide-127 which had the same linear flow of air (12.2 m/min) and contact time (0.25 sec.) as the RDT M16 Test Procedure. Only one-fourth of the charcoal was used (in a bed 2.54 cm diameter and 5.08 cm high) and the required dose of methyl iodide-127 was reduced from 5.25 to 1.31 mg. The inlet concentrations were determined with a gas chromatograph and the effluent concentrations with a modified microcoulombmeter. Two calibration procedures were used: (1) known vapor pressure of iodine crystals, and (2) quantitative pyrolysis of the methyl iodide-127 delivered from certified permeation tubes. Five charcoals and three impregnations were used in this study. Typical behaviors are given in 90% RH air with the charcoals either prehumidified for 16 hours at 90% RH or without the prehumidification. The breakthrough curves, concentration versus time, rose very slowly for the first 120 minutes and then more rapidly for an additional time. The lack of a dependence on the magnitude of the dose is compatible with a catalytic trapping mechanism. In the case of KI/sub x/ impregnations, there was excess emission of iodine during purging over that introduced as methyl iodide-127 which must have originated in the reservoir of iodine contained in the impregnation.

40400 (CONF-780819—P1, pp 335-351) **Effect of pore structure on the activated carbon's capability to sorb airborne methylradioiodine.** Juhola, A.J.; Friel, J.V. (MSA Research Corp., Evans City, PA). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

A study was conducted to determine the effect pore structure of activated carbons has on their capabiity to sorp airborne methylradioiodine. Six de-ashed carbons of very diverse pore structure were selected for study. Batches of each were impregnated with (1) 4.3% I_2, (2) 5.6% KI, (3) 2% KI, (4) 3% KI to 2% I_2, (5) 2% I_2, and (6) 3.4% KIO_3. Some carbon was reserved for testing without impregnant. Standard procedures at ambient temperature and pressure were followed in the methyliodide testing, with some changes only made to meet the requirements of the specialized study. The surface area of the open-pore volume, for KI impregnated carbons, determined the sorptive efficiency. This relationship is expressed by the equation $\ln p = \ln a - ks$, where p is the fraction of methyliodide penetrating the bed and s the surface area. The quantity (a) is associated with the macropore properties, and deterines the capability of the carbon to sorb at very high humidites (> 95% RH). Constant k is to a large degree dependent on the mean diameter of the micropores. Elemental iodine impregnated carbons were considerably less effective than those impregnated with KI, and their sorptive of methyliodide did not follow the above equation. Their activity could be increased by a second impregnation with KOH. KI impregnated carbons lost their activity when treated with HCl on converting the Ki to I_2. The conversion of KI to I_2 by acid gases in nuclear power plants offers an explanation for the cause of carbon aging.

40401 (CONF-780819—P1, pp 368-378) **Evaluation and control of poisoning of impregnated carbons used for organic iodide removal.** Kovach, J.L.; Rankovic, L. (Nuclear Consulting Services, Inc., Columbus OH). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

By the evaluation of the chemical reactions which have taken place on impregnated activated carbon surfaces exposed to nuclear reactor atmospheric environments, the role of various impregnants has been studied. The evaluation shows several different paths for the aging and posioning to take place. The four major causes were found to be: organic solvent contamination; inorganic acid gas contamination; formation of organic acids on carbon surface; and, formation of SO_2 from carbon sulfur content. Prevention of poisoning by the first two paths can be accomplished only by procedural changes within the facility. However the last three poisoning paths can be controlled to some extent by the selection of carbon pretreatment techniques and the type of impregnant used. Results were generated by evaluating used carbons from 14 nuclear power plants and by artificial poisoning of laboratory impregnated carbons. Impregnants which have antioxidant properties, besides reaction with

organic iodides, can increase the life of the impregnated activated carbons.

40402 (CONF-780819—P1, pp 437-445) **AECL iodine scrubbing project.** Torgerson, D.F.; Smith, I.M. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

A gas phase chemistry approach to organic iodide scrubbing is described, which achieves large removal efficiencies for iodomethane and iodobenzene from air. Low energy electrons, ions, and reactive neutral species are generated using a corona discharge through which the gas flow is directed. Organic iodides are rapidly decomposed to form an inorganic, iodine-containing compound which precipitates from the flow. Electrons and negative ions appear to be the most effective scavengers for organic iodides since negative voltage discharges have the highest scrubbing efficiency. The iodine-containing precipitate is an amorphous iodine/oxygen compound which decomposes to form crystalline I_2O_5 on heating.

40403 (CONF-780819—P1, pp 512-522) **Noble gas separation with the use of inorganic adsorbents.** Pence, D.T.; Chou, C.C.; Christian, J.D.; Paplawsky, W.J. (Science Applications, Inc., San Diego, CA). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

A noble gas separation process is proposed for application to airborne nuclear fuel reprocessing plant effluents. The process involves the use of inorganic adsorbents for the removal of contaminant gases and noble gas separation through selective adsorption. Water and carbon dioxide are removed with selected zeolites that do not appreciably adsorb the noble gases. Xenon is essentially quantitatively removed with a specially developed adsorbent using conventional adsorption-desorption techniques. Oxygen is removed to low ppM levels by the use of a rapid cycle adsorption technique on a special adsorbent leaving a krypton-nitrogen mixture. Krypton is separated from nitrogen with a special adsorbent operated at about -80°C. Because the separation process does not require high pressures and oxygen is readily removed to sufficiently limit ozone formation to insignificant levels, appreciable capital and operating cost savings with this process are possible compared with other proposed processes. In addition, the proposed process is safer to operate.

40404 (CONF-780819—P1, pp 547-569) **Removal of ^{14}C-contaminated CO_2 from simulated LWR fuel reprocessing off-gas by utilizing the reaction between CO_2 and alkaline hydroxides in either slurry or solid form.** Holladay, D.W.; Haag, G.L. (Oak Ridge National Lab., TN). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

An important consideration in the design of a LWR fuel reprocessing plant is the removal of ^{14}C-contaminated CO_2 from the process off-gas. The separation and fixation of essentially all the CO_2 from the simulated off-gas can be accomplished by reaction with alkaline slurries in agitated tank-type contactors. Based on efficacy for CO_2 removal, consideration of reactant cost, and stability of the carbonate product as related to long-term storage requirements, the two most promising slurry reactants for CO_2 removal from low CO_2-content feed gases are $Ca(OH)_2$ and $Ba(OH)_2$. The removal of ^{14}C-contaminated CO_2 from simulated LWR off-gases was studied as a function of both operating conditions and varying sizes of bench-scale design. Parametrically, the effects on the CO_2 removal rate of feed composition (330 ppM - 4.47% CO_2), impeller speed (325 to 650 rpm), superficial velocity (5 to 80 cm/min), reactants [$Mg(OH)_2$, NaOH], contactor size (20.3 cm and 27.3 cm ID), and type of operation (semibatch or continuous slurry) were deterined.

40405 (CONF-780819—P1, pp 584-599) **Investigation of air cleaning processes for removing tributyl phosphate vapors from fuel reprocessing off-gas streams.** Parker, G.B.; Schwendiman, L.C. (Pacific Northwest Lab., Richland, WA). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Tributyl phosphate (TBP) is used as an extractant in combination with the solvent dodecane in the dissolution process in a conventional nuclear fuel reprocessing plant. When recycled acid is used in the process, the dissolver off-gas (DOG) may contain small amounts of TBP and dodecane vapor. The vessel off-gas (VOG) will also contain TBP vapors in even higher fractions. Under some conditions, TBP vapor in these gas streams adversely affects the performance of silver-loaded solid sorbent beds used in the treatment of these streams to remove iodine and organic iodide compounds. An investigation is reported of the use of inorganic solid sorbent beds located upstream of the silver-loaded sorbent beds to remove TBP and extend the useful life of the silver beds. Laboratory scale experiments have been conducted using selected inorganic solid sorbent materials which have specific properties indicating their effectiveness for removing TBP or similar organic compounds. Results indicated 4 inorganic materials would retain greater than 95% of inlet TBP over a 3-hour run time. These four materials are being tested in a small packed glass column arrangement using variations in TBP concentration, face velocity and column temperature. As a part of this work, a sensitive quantitative analysis technique was developed enabling continous real time analysis of TBP vapor concentrations, as low as 1×10^{-7} g/l, so that breakthrough progression can be measured.

40406 (CONF-780819—P1, pp 614-625) **Elimination of NO/sub x/ by selective reduction with NH_3.** Bruggeman, A.; Meynendonckx, L.; Gossens, W.R.A. (SCK/CEN, Mol, Belgium). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

In nuclear reprocessing plants the nitrogen oxides generated during the dissolution of the fuel are only partially removed in the primary off-gas treatments. Further reduction to the ppM level is necessary as a preliminary step to the cryogenic retention and separation of the noble gases. If simultaneous oxygen removal is not required, selective reduction of NO (and NO_2) to N_2 and H_2O by NH_3 is a preferable method. Laboratory experiments have confrmed the feasibility of eliminating NO from air beyond the ppM level by adding NH_3 over a hydrogen mordenite catalyst. At atmospheric pressure and with air (water content 0.5% V/V) as a carrier gas selective catalytic reduction of NO to N_2 is easily achieved at temperatures up to 500°C. Under the same conditions dimensioning of the reactor for destruction of the excess NH_3 by the O_2 of the air is made possible. The activity of the catalyst remains rather constant even when large concentrations of I_2 are present. On the basis of the laboratory results a pilot installation has been designed and constructed which will demonstrate the process in an integrated gas purification loop at a pressure of 8×10^5 Pa during the next months.

40407 (CONF-780819—P2) **Proceedings of the fifteenth DOE nuclear air cleaning conference.** First, M.W. (ed.). (Department of Energy, Washington, DC (USA); Harvard Univ., Boston, MA (USA). Harvard Air Cleaning Lab.). Feb 1979. 630p. Dep. NTIS, PC A99/MF A01.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Papers presented are grouped under the following topics: noble gas separation, damage control, aerosols, test methods, new air cleaning technology from Europe, open-end, and filtration. A separate abstract was prepared for each paper.

40408 (CONF-780819—P2, pp 627-639) **Dynamic adsorption of radon on activated carbon.** Strong, K.P.; Levins, D.M. (Australian Atomic Energy Commission, Sydney, Australia). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

The adsorption of ^{222}Rn from air onto activated carbon was studied over the range 0 to 55°C. A sharp pulse of radon was injected into an air stream that flowed through a bed of activated carbon. The radon concentration in the exit from the column was continuously monitored using a zinc sulfide α-scintillation flow cell. Elution curves were analyzed to determine the dynamic adsorption coefficient and the number of theoretical stages. Five types of activated carbon were tested and the dynamic adsorption coefficient was found to increase linearly with surface area in the range 1000 to 1300 m^2g^{-1}. The adsorptive capacity of activated carbon was reduced by up to 30% if the entering gas was saturated with water vapor and the bed was initially dry. If the bed was allowed to equilibrate with saturated air, the adsorptive capacity was too low to be of practical use. The minimum height equivalent to a theoretical stage (HETS) was about four times the particle diameter and occurred at superficial velocities within the range 0.002 to 0.02 m s^{-1}. For superficial velocities above 0.05 m s^{-1}, the HETS was determined by the rate of mass transfer. The application of these results to the design of activated carbon systems for radon retention is discussed.

40409 (CONF-780819—P2, pp 640-651) **Development of a cryogenic krypton-separation system for the offgas of reprocessing plants.** von Ammon, R.; Burkhardt, H.G.; Hutter, E.; Neffe, G. (Kernforschungszentrum Karlsruhe GmbH, Germany). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

The concept of cryogenic rare gas separation from reprocessing offgas pursued at present at the Kernforschungszentrum Karlsruhe (KFK) is discussed and compared with other offgas purification flowsheets. The KFK concept includes: separation of O_2 and residu-

al NO/sub x/ by catalytic reduction with H_2, adsorptive retention of H_2O, CO_2, NH_3 etc. and cryogenic distillation of first N_2-Kr-Xe, then Kr-Xe mixtures. Some features pertinent to this flowsheet which were studied experimentally either on a laboratory or semiworks scale, are described including the following: desublimation of Xe in the first column, coadsorption of Kr at and its selective desorption from the adsorption bed, purification of the Xe product, poisoning of the reduction catalyst and methanization of CO_2. It is shown that all of these features, despite being capable of causing malfunctions of the process, can be controlled by proper process design and operational conditions in a way not to impair with a good Kr decontamination factor.

40410 (CONF-780819—P2, pp 893-900) **Experimental determination of fission gas adsorption coefficients.** Lovell, R.; Underhill, D.W. (Harvard School of Public Health, Boston, MA). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Large charcoal beds have been used for a number of years for the holdup and decay of radioactive isotopes of krypton and xenon. Reliable design of these beds depends on an accurate knowledge of the adsorption coefficient of krypton and xenon on the adsorbents used in these beds. It is somewhat surprising that there is no standard procedure of determining the adsorption coefficient for krypton and xenon. Fundamental information needed to establish a standardized reproducible test procedure is given emphasizing the breakthrough curves commonly used to analyze dynamic adsorption data can lead to serious systematic errors and the fact that the adsorption coefficient, if calculated from the arithmetic holding time, is independent of geometric factors such as the shape of the adsorption bed and the irregular shape of the adsorbent.

40411 (CONF-780819—P2, pp 947-949) **New air cleanig technology in the United Kingdom.** Dorman, R.G. (Chemical Defense Establishment, Porton, London). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Development in air cleaning technology in the UK are reviewed. (JRD)

40412 (CONF-780819—P2, pp 950-955) **Some developments in nuclear air cleaning in France.** Sigli, P. (Commissariat a l'Energie Atomique, Fontenay-Aux-Roses, France). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Developments in air cleaning is discussed in sections on iodine testig, iodine trapping in reprocessing plants, krypton recovery, and the trilex process for tritium removal in fuel reprocessing. (JRD)

40413 (CONF-780819—P2, pp 956-962) **Gas cleaning research and engineering in Belgium.** Goossens, W.R.A.; Baetsle, L.H.; Bruggeman, A.; Collard, G. (SCK/CEN, Mol, Belgium). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

A survey is presented of the Belgian R and D program on gas cleaning. From the short survey given it can be concluded that SCK/CEN at Mol is well prepared to investigate any nuclear gas cleaning problem that may arise in the future. A complete set of laboratory and technical units are available for this purpose. In the future, the Belgian technical possibilities in this field will increase further as soon as the Head-End Research facility on the Mockup Engineering Scale (HERMES) of 10 kg irradiated fuel per batch is operational.

40414 (CONF-780819—P2, pp 963-970) **Developments in nuclear air cleaning in Germany.** Wilhelm, J.G. (Kernforschungszentrum Karlsruhe GmbH, Germany). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

The recent developments of nuclear filters in the Federal Republic of Germany were prompted by the intention of a German nuclear power plant manufacturer to simplify the handling of contaminated nuclear filters and minimize the space requirement for the radioactive waste accumulating. The design and performance of high efficiency filters are discussed along with iodine sorption filters. Information is also included on off gas treatment in reprocessing plants for spent LWR and HTCR fuels. (JRD)

40415 (CONF-790420—10) **Development of cermets for high level radioactive waste fixation.** Aaron, W.S.; Quinby, T.C.; Kobisk, E.H. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 15p. Dep. NTIS, PC A02/MF A01.

From International symposium on ceramics in nuclear waste management; Cincinnati, OH, USA (30 Apr 1979).

A method for the solidification and fixation of commercial and defense high-level radioactive wastes, namely a cermet process, is currently under development. Chemical and physical processing techniques, as developed up to this time, and the subsequent properties of the resulting cermet bodies are described; unique and advantageous features of the cermet waste form and the conversion process are discussed.

40416 (ICP—1183) **Application of microwave energy to post-calcination treatment of high-level nuclear wastes.** Priebe, S.J.; Piper, T.C.; Berreth, J.R. (Idaho National Engineering Lab., Idaho Falls (USA)). Feb 1979. Contract EY-76-C-07-1570. 34p. Dep. NTIS, PC A03/MF A01.

Two potential applications of microwave energy for treatment of high-level nuclear waste are drying of a pelleted waste and vitrifying of a calcined waste. Tests showed pellet drying by microwave energy to be superior to drying by conventional methods. Vitrification by microwave energy gave a uniform glass in less time than radiant energy. 9 figures, 4 tables.

40417 (ICP—1185) **Development of a pelleted waste form for high-level ICPP zirconia wastes.** Lamb, K.M.; Cole, H.S. (Allied Chemical Corp., Idaho Falls, ID (USA). Idaho Chemical Programs - Operations Office). Apr 1979. Contract EY-76-C-07-1540. 40p. Dep. NTIS, PC A03/MF A01.

Simulated high-level ICPP zirconia waste calcine is pelletized on a 41-cm-diam pelletizer using 5% bentonite, 2% metakaolin, and 2% boric acid for solids binders and 7M phosphoric and 4M nitric acid as the liquid binders. After heat treatment at 800°C for 2 hours, the pellets are impact resistant and have a leach resistance of 10^{-4} g/cm^2/day, based on Soxhlet leaching for 100 h at 95°C with distilled water.

40418 (MLM—2609) **Commercial Cyclone Incinerator Demonstration Program: October 1978—March 1979.** Alexander, B.M. (Mound Facility, Miamisburg, OH (USA)). 30 Apr 1979. Contract AC04-76DP00053. 16p. Dep. NTIS, PC A02/MF A01.

The commercial cyclone incinerator program was designed to study the effects of burning low-level waste contaminated with beta and gamma emitters in a cyclone system. The ultimate program goal is the demonstration of a cyclone incinerator at a nuclear power plant. During the past six months, the first three tasks in the project milestone schedule were completed; the project schedule itself covers the period from January 1979 through June 1981. The plan to demonstrate the feasibility of incinerating beta- and gamma-contaminated waste was developed utilizing an extensive literature search, making design modifications to the laboratory cyclone incinerator, and designing an experimental plan. A summary of the feasibility plan was then written and reviewed. It is currently being revised for submission to the Nuclear Regulatory Commission. Following informal NRC review of the feasibility plan, laboratory-scale experiments will begin.

WASTE DISPOSAL AND STORAGE

REFER ALSO TO CITATION(S) 40182, 40452, 40453

40419 (CONF-780819—P1, pp 231-243) **Catalytic removal of ozone produced in radioactive media.** Penzhorn, R.D.; Guenther, K.; Schuster, P. (Kernforschungszentrum karlsruhe, Germany). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Eighteen materials and catalysts were tested for their catalytic efficiency in decomposing ozone. The best results at 80°C and linear flow velocities if O_2/O_3 mixtures between 0 and 0.9 (m/s) were obtained with catalysts containing silver or palladium. Catalysts containing platinum proved to be particularly inactive. A Ag on Al_2O_3 catalyst removed ozone with 100% efficiency from a 700 l/h gas stream carrying approx. 35 O_3/l even at temperatures as low as -80°C. For several catalysts a further decrease in temperature, i.e.: below -60°C, was accompanied by an increase in the rate of ozone removal. The highest efficiency at cryogenic temperatures was obtained with a silver catalyst. From a systematic investigation of the inhibiting effect of nitrogen oxides on the catalytic ozone destruction, it was concluded that catalysts containing pallidium are most resistant to N/sub x/O/sub y/ poisoning. Ozone and oxygen can be eliminated simultaneously, down to the ppM range, from a process gas with a previously reduced copper catalysts. For this purpose Al_2O_3 is a better metal carrier than SiO_2, the specific area providing a good criterion for catalyst selection. N/sub x/O/sub y/ poisoning of Cu catalysts is reversible and comparatively insignificant.

40420 (CONF-780819—P2, pp 998-1004) **Radioactive waste management: the need for multiple barriers.** Sokol, J.; Cooper, M.

(Westinghouse Advanced Power Systems Div., Madison, PA). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Isolation criteria for the disposal of high-level radioactive waste are critically examined. The results indicate that the essential period for isolation of high-level waste is about 1,000 years. Multiple barriers, such as a solidified, leach-resistant waste form (i.e. fixation in glass), a corrosion-resistant outer container, and a stable geological formation, which limit the transport of radioactivity into the human food-chain are recommended. The multiplicity of barriers allows for the unlikely event of failure in one or two of the barriers while still providing adequate isolation of the waste.

40421 (DPSPU—79-11-1) **History of waste tank 9 , 1955—1974.** Tharin, D.W.; Lohr, D.R. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Jan 1979. Contract EY-76-C-09-0001. 44p. Dep. NTIS, PC A03/MF A01.

Tank 9 was placed in service as a receiver for Purex HLW on July 19, 1955. Filling was essentially completed in December 1955, and this original complement of waste remained in the tank until December 1965, when most of the liquid was decanted to allow refilling. In July 1966, the remaining liquid and approximately 15 inches of sludge were removed using 3000 to 3500 psi water introduced through nozzles to mobilize the sludge. The tank was then used as a receiver and cooler for aged HLW solution concentrated by the tank farm evaporator; the resulting crystallized salt, covered with saturated solution, is now stored in this tank. Inspections have been made of the tank interior and annulus by direct observation and with a 40-ft optical periscope. Analytical samples have been taken of the sludge, supernate, vapor, and leaked material in the annulus. Top-to-bottom profiles of radiation and temperature have been obtained in the annulus and tank, respectively, and measurements have been made of roof deflection caused by salt adhering to roof-supported cooling coils. Leaked waste was discovered in the annulus pan in October 1957. During 1958-59, the annulus pan was flushed nine times with water in 2000-gallon batches, jetting the waste and flush water into the primary tank. However, waste leakage into the annulus continued. The maximum liquid depth reached in the annulus was about 12 inches. This was jetted out in 1961., but some leakage continued theeeafter as indicated by roddings. The roddings showed no standing liquid by August 1964, but some liquid may have been present undera salt crust. In March 1972, salt depth in the annulus was measured to be 8 to 10 in., and the bottom 3 in. was quite wet. The salt remains although most of the liquid has been removed.

40422 (ICP—1189) **Properties of radioactive calcine retrieved from the second calcined solids storage facility at ICPP.** Staples, B.A.; Pomiak, G.S.; Wade, E.L. (Allied Chemical Corp., Idaho Falls, ID (USA). Idaho Chemical Programs - Operations Office). Mar 1979. Contract EY-76-C-07-1540. 65p. Dep. NTIS, PC A04/MF A01.

The chemical and physical properties of radioactive alumina and zirconia calcine samples retrieved from the storage bins at ICPP were measured. Chemical properties measured include chemical composition, crystalline structure, and radiochemical composition. The physical properties measured and reported include density, size distribution, relative attrition, solubility in 8 M HNO_3, thermal stability, and flow characteristics. The chemical and physical properties of the retrieved calcine after the 10 to 12 years of storage are very similar to freshly prepared simulated calcine.

40423 (INIS-mf—4552) **Disposal of high-level wastes from Danish nuclear power plants. V. 1. Text.** (ELKRAFT A.m.b.A., Hellerup (Denmark); Jysk-Fynske Elsamarbejde (ELSAM), Fredericia (Denmark)). Jul 1978. 59p. (In Danish). Dep. NTIS (US Sales Only), PC A04/MF A01.

The results of a preliminary evaluation of the need for and the possibilities of a geologic repository for high-level wastes situated in Denmark are presented. The work has been concentrated on a repository in rock salt, partly because salt offers some special advantages for disposal of high-level wastes, and partly because similar repositories in other countries are planned to be built and operated during the next ten years. The structural and mechanical parts of the construction are thus being developed in other countries and will meet the requirements that are approved by the authorities in these countries. The investigations confirm that such a repository could be realized in a suitable salt horst and that there is every probability that one could be found among the Danish salt horsts. Furthermore the results demonstrate that disposal of radioactive waste in a salt horst is very safe and that the structure of the horst and the salt composition does not seem to be very important (author).

40424 (INIS-mf—4553) **Disposal of high-level wastes from Danish nuclear power plants. V. 2. Supplement.** (ELKRAFT A.m.b.A., Hellerup (Denmark); Jysk-Fynske Elsamarbejde (ELSAM), Fredericia (Denmark)). Jul 1978. 57p. (In Danish). Dep. NTIS (US Sales Only), PC A04/MF A01.

Fifty seven figures are presented on several aspects of disposal of high-level radioactive wastes in Denmark, published as a supplement to the report 'Disposal of high-level radioactive wastes from nuclear power plants'.

40425 (LA—7649-PR) **Studies of transuranic waste storage under conditions expected in the waste isolation pilot plant (WIPP). Progress report, October 1—December 15, 1978.** Kosiewicz, S.T.; Barraclough, B.L.; Zerwekh, A. (Los Alamos Scientific Lab., NM (USA)). Mar 1979. Contract W-7405-ENG-36. 18p. Dep. NTIS, PC A02/MF A01.

This is the fifth quarterly report describing progress in an experimental program to determine the effects of radiolytic, thermal, and catalyzed pyrolytic degradation of various forms of existing or proposed transuranic contaminated wastes. Preliminary data appear to indicate that G(gas) is dose-rate independent. The rate of evolution of radiolytically generated gases decreases with increasing exposure time. More gas is evolved by radiolysis at 70°C than at 20°C. A summary of other work on alpha radiolysis of organics is provided. The rates of cement paste dewatering have been determined at 40 and 100°C. Characterization of (1) waste types, (2) waste containers, and (3) radionuclide occurrences are presented in detail in the Los Alamos Scientific Laboratory TRU waste inventory assessment. 8 tables.

40426 (LBL—7062) **Data acquisition, handling, and display for the heater experiments at Stripa.** McEvoy, M.B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Feb 1979. Contract W-7405-ENG-48. 79p. (SAC—14). Dep. NTIS, PC A05/MF A01.

In June 1978, a joint Swedish/American research team began acquiring data from the Stripa mine in Sweden, 340 m below the surface. Electrical heaters are used to assess the suitability of granite rock as a repository for radioactive waste material. Extensive instrumentation also measures temperature, stress, and displacement effects caused by these heaters. This report describes the data acquisition system, its design considerations, capabilities, and operational use. The techniques employed to detect and analyze any anomalous experimental results are also described. Environmental considerations are described in an appendix.

40427 (LBL—7063) **Electrical heaters for thermo-mechanical tests at the Stripa mine.** Burleigh, R.H.; Binnall, E.P.; DuBois, A.O.; Norgren, D.U.; Ortiz, A.R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jan 1979. Contract W-7405-ENG-48. 58p. (SAC—13). Dep. NTIS, PC A04/MF A01.

Electrical heaters were installed at the Stripa mine in Sweden to simulate the heat flux expected from canisters containing nuclear waste. Three heater types were designed and fabricated: two full scale heaters, 2.6 m in length and 324 mm in diameter, supplying a maximum power output of 5 kW; eight peripheral heaters of 25 mm diameter, supplying 1.1 kW; and eight time scale heaters, one-third the size and power of the full scale heaters. The heater power can be monitored by panel meters as well as by a computer-based data acquisition system. Both the controller and the heater were designed with a high degree of redundancy in case of component failure. Auxiliary items were provided with the heaters to monitor borehole decrepitation and heater temperature, and to dewater the heater holes. This report describes the above systems and relates experience gained during testing, installation, and operation.

40428 (LBL—7069(Vol.1)) **Preliminary thermal and thermomechanical modeling for the Near Surface Test Facility heater experiments at Hanford.** Chan, T.; Remer, J.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1978. Contract W-7405-ENG-48. 109p. Dep. NTIS, PC A06/MF A01.

Preliminary thermal and thermomechanical analyses have been carried out for the heater experiments in the Near Surface Test Facility at Gable Mountain on the Hanford Reservation, Richland, Washington. Temperatures were calculated by Green's function method for the full-scale and time-scaled experiments. Six different heater power schedules were considered for the full-scale experiments to bracket all possible values of initial spent fuel power from canisters buried after different periods of cooling. Linear elastic finite-element models were used to calculate the thermally induced displacements and stresses for two of the power schedules. Due to the poor thermal conductivity and rather high Young's modulus of Pomona basalt (the rock type in which the heater experiments are to be conducted), very high temperatures, displacements and stresses were predicted in spite of the relatively low thermal expansion coefficient. These predicted values have been used for the design of the experiments. Recommendations are made in this report regarding the conduct of the experiments and the interpretation of the field data, as well as further thermomechanical modeling and input data required for more meaningful modeling of a fractured rock mass. Equations are given in Appendices A and B for temperatures caused by an arbitrary time-dependent cylindrical heater of finite length and

radius, a finite-radius disc heater, as well as the generalization to the situation of an anisotropic medium.

40429 (LBL—8801) **Investigations in granite at Stripa, Sweden for nuclear waste storage.** Witherspoon, P.A.; Gale, J.E.; Cook, N.G.W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; Waterloo Univ., Ontario (Canada)). Jan 1979. Contract W-7405-ENG-48. 5p. (CONF-790602—37). Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; Atlanta, GA, USA (3 Jun 1979).

Fuel-scale and time-scaled heater experiments are underway in a large granite rock mass adjacent to an abandoned iron-ore mine at Stripa, Sweden. Predicted and measured temperature fields over the past several months are in excellent agreement for both series, but discontinuities are affecting the mechanical behavior. Fracture hydrology is also being investigated. (DLC)

40430 **Radioactive waste in geologic storage.** Fried, S. (ed.). Washington, DC; American Chemical Society (1979). 351p. (CONF-780902—P5). $29.50.

From American Chemical Society meeting; Miami, FL, USA (10 Sep 1978).

Seventeen papers are included on the following topics: general geologic and hydrologic considerations involved in a deep repository; leaching characteristics of source terms; and sorption behavior of various nuclides on minerals, rocks, and clays relating to migration and possible entrance into the biosphere. Separate abstracts were prepared for 15 of the papers; the remaining two were previously abstracted. (DLC)

40431 (PNL—2642) **Waste isolation safety assessment program. Technical progress report for FY-77.** Burkholder, H.C.; Greenborg, J.; Stottlemyre, J.A.; Bradley, D.J.; Raymond, J.R.; Serne, R.J. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1979. Contract EY-76-C-06-1830. 245p. Dep. NTIS, PC A11/MF A01.

Purpose of WISAP is to evaluate the post-closure effectiveness of deep geologic nuclear waste repository systems. The work conducted centered in four subject areas: (1) the analysis of potential repository release scenarios, (2) the analysis of potential release consequences, (3) the measurement of waste form leaching rates, and (4) the measurement of the interactions of dissolved radionuclides with geologic media. 12 figures, 24 tables.

40432 (UCRL—13992) **Preliminary study of radioactive waste disposal in the vadose zone.** (Geotechnical Engineers, Inc., Winchester, MA (USA)). Sep 1978. Contract W-7405-ENG-48. 311p. Dep. NTIS, PC A14/MF A01.

To investigate the characteristics of the vadose zone with respect to radioactive waste disposal, the mechanics of unsaturated flow in arid regions and the geohydrology of four areas with a deep water table were studied. The studies indicated that (1) arid sites with a water table deeper than 200 m can be found in at least three distinct geologic settings in the western United States, (2) the physics of unsaturated flow in soils and rock with interstitial porosity at low water contents, particularly under thermal gradients, is not yet completely understood, and (3) under certain conditions unsaturated flow can be so slow that analytic modeling of an unflawed repository is unnecessary to prove effective containment.

40433 (UCRL—13998-1) **Notes on the LLL/NRC waste disposal study. I, analytical framework.** (Kaplan and Associates, Inc., Livermore, CA (USA)). Mar 1978. Contract W-7405-ENG-48. 22p. Dep. NTIS, PC A02/MF A01.

Purpose of these notes is to suggest some language (notation, public health risk), ideas, and points of view which may be useful in focusing discourse and work on the NRC Waste Disposal Study. (DLC)

40434 (UCRL—13998-2) **Notes on the LLL/NRC waste disposal study. II, probabilistic arithmetic.** (Kaplan and Associates, Inc., Livermore, CA (USA)). May 1978. Contract W-7405-ENG-48. 20p. Dep. NTIS, PC A02/MF A01.

UCRL-13998-1 outlined a formalism for risk analysis of nuclear waste disposal systems. This note looks more deeply at the probabilistic calculations necessary for its implementation. Both the underlying philosophy and the computation technique of these calculations are discussed.

40435 (Y/OWI/TM—43/8) **Office of waste isolation progress report, May 1978.** Rhines, R.C. (ed.). (Union Carbide Corp., Oak Ridge, TN (USA). Office of Waste Isolation). May 1978. Contract W-7405-ENG-26. 69p. Dep. NTIS, PC A04/MF A01.

Technical projects, facility projects, planning and analysis, and regulatory affairs are reported on. Startup of the remaining two heater experiments in the Avery Island Mine in Louisiana took place June 1. (DLC)

40436 **Department of Energy program for long-term isolation of radioactive waste.** Heath, C.A. (Dept. of Energy, Washington, DC). pp 1-11 of Radioactive waste in geologic storage. Fried, S. (ed.). Washington, DC; American Chemical Society (1979).

From American Chemical Society meeting; Miami, FL, USA (10 Sep 1978).

DOE is charged by Congress with the responsibility for managing high-level radwaste from commercial uses of nuclear power; this radwaste may be either spent fuel elements or solidified reprocessing wastes. This paper reviews the organization of DOE's waste management program, the technical issues involved, interactions between the waste form and surrounding minerals, properties of the host rock, hydrogeologic transport, and risk assessment. The problem of opposition to studies of specific candidate sites is pointed out. (DLC)

40437 **Hydrologic considerations related to management of radioactive waste.** Debuchananne, G.D.; Wood, W.W. (Geological Survey, Reston, VA). pp 37-46 of Radioactive waste in geologic storage. Fried, S. (ed.). Washington, DC; American Chemical Society (1979).

From American Chemical Society meeting; Miami, FL, USA (10 Sep 1978).

The hydrologic evaluation of radionuclide migration from a repository is centered on three areas of uncertainty: the existing hydrologic system at a given site, prediction of events (earthquakes, etc.) altering the hydrologic properties with time, and evaluating the interaction of wastes with the burial environment. The volumes and types of waste are briefly considered. Problems in making the hydrologic evaluation are discussed. (DLC)

40438 **Disposal of radioactive waste in granitic bedrock.** Allard, B.; Rydberg, J.; Kipatsi, H.; Torstenfelt, B. (Chalmers Univ. of Tech., Goeteborg, Sweden). pp 47-73 of Radioactive waste in geologic storage. Fried, S. (ed.). Washington, DC; American Chemical Society (1979).

From American Chemical Society meeting; Miami, FL, USA (10 Sep 1978).

It is essential that the ground, which is the final barrier and the only barrier not man-made, by itself can prevent the migrating radionuclides from an underground waste depository from giving unacceptable doses to any critical group in the future. Although the sorption processes in the ground are not clearly understood, the results obtained so far seem to be adequate to prove the feasibility of an absolutely safe disposal, as required by the Swedish law. The majority of the international experts and organizations that have been consulted for critical reviewing of the KBS-reports also seems to accept the validity of the conclusions drawn regarding the safety of the disposal method. 35 references, 6 figures, 9 tables.

40439 **Leaching of fully radioactive high-level waste glass and waste—geologic environment interaction studies.** Bradley, D.J. (Battelle Pacific Northwest Labs., Richland, WA). pp 75-91 of Radioactive waste in geologic storage. Fried, S. (ed.). Washington, DC; American Chemical Society (1979).

From American Chemical Society meeting; Miami, FL, USA (10 Sep 1978).

The release rate was determined for 10 radioisotopes from fully radioactive waste glasses in deionized water for a period of 1.75 years. For cesium and strontium, good agreement exists between the leach rates for simulated and fully radioactive glass of the same composition. The release rate mechanism is dependent on time, sampling frequency, and type of element. For this study, only sampling intervals greater than one month had significant impact on the leach rate. Over the long testing period two different release mechanisms occurred. 8 figures, 3 tables.

40440 **Single-pass leaching of nuclear melt glass by groundwater.** Coles, D.G.; Weed, H.C.; Jackson, D.D.; Schweigeer, J.S. (Univ. of California, Livermore). pp 93-114 of Radioactive waste in geologic storage. Fried, S. (ed.). Washington, DC; American Chemical Society (1979).

From American Chemical Society meeting; Miami, FL, USA (10 Sep 1978).

Melt glass (fused rock containing fission and activation products and actinides) produced by three underground nuclear explosions has been leached at 25°C with groundwater obtained from a well near the explosion sites. Leaching was carried out in cells with the groundwater passing over glass particles (size range: 40 to 130 μm) at flow rates of 36 and 6.7 cm/day. With this dynamic flow-through system, the solid sample is continually exposed to fresh leaching solution in an attempt to simulate actual underground conditions. Radionuclide concentrations in the leachate were obtained at intervals of 1, 2, 3, 6, 11, 32, 38, 70, and 120 days after the leaching began. The fraction of radioactivity leached per day per M^2 surface area varied from 1.5×10^{-2} for ^{22}Na on Day 1 to 7.0×10^{-6} for ^{144}Ce on Day 120. Except for ^{144}Ce, leaching rates did not seem to depend significantly on flow rates. 10 figures, 5 tables.

40441 Method for determining leach rates of simulated radioactive waste forms. Flynn, K.F.; Jardine, L.J.; Steindler, M.J. (Argonne National Lab., IL). pp 115-127 of Radioactive waste in geologic storage. Fried, S. (ed.). Washington, DC; American Chemical Society (1979).

From American Chemical Society meeting; Miami, FL, USA (10 Sep 1978).

Measurement of leach rates of high-level radioactive waste by neutron activation is described and some results presented. This method is most useful for very low leach rates. 3 tables. (DLC)

40442 Field study of radionuclide migration. Hoffman, D.C. (Los Alamos Scientific Lab., NM). pp 149-166 of Radioactive waste in geologic storage. Fried, S. (ed.). Washington, DC; American Chemical Society (1979).

From American Chemical Society meeting; Miami, FL, USA (10 Sep 1978).

The radionuclide distribution in both the water and aggregate around a 0.75-kt nuclear test which was detonated below the water table at the Nevada Test Site was investigated. An extensive suite of sidewall core samples was obtained from near the surface to below the original cavity region. Representative water samples were pumped from five different zones in the cavity and rubble regions. Most of the radioactivity was found in solid material contained in the lower cavity region. Water pumped from the region of highest radioactivity showed only tritium and strontium-90 at levels higher than the recommended concentration guides for drinking water. Water is being pumped from a satellite well some 90 m away to induce an artificial gradient and draw water from the test zone.

40443 Kinetic effects in migration. Friedman, A.M.; Fried, S. (Argonne National Lab., IL). pp 191-199 of Radioactive waste in geologic storage. Fried, S. (ed.). Washington, DC; American Chemical Society (1979).

From American Chemical Society meeting; Miami, FL, USA (10 Sep 1978).

It is shown that equilibrium chromatographic elution does not always occur in geological materials; a plume may form in the direction of flow. There are three possible causes: abnormal flow paths, absorption on colloidal, nonabsorbing particles, and a flow rate too fast for equilibrium. 6 figures. (DLC)

40444 Studies of actinide sorption on selected geologic materials. Silva, R.J.; Benson, L.V.; Apps, J.A. (Univ. of California, Berkeley). pp 215-240 of Radioactive waste in geologic storage. Fried, S. (ed.). Washington, DC; American Chemical Society (1979).

From American Chemical Society meeting; Miami, FL, USA (10 Sep 1978).

Adsorption of U, Np, Am, Pu, and Cm on umtanum basalt, quartz monzonite, and Eleana shale was studied using batch-type tracer techniques. Adsorption and desorption coefficients were calculated, and results are discussed in detail. 11 figures, 9 tables, (DLC)

40445 Radionuclide sorption studies on abyssal red clays. Erickson, K.L. (Sandia Labs., Albuquerque, NM). pp 267-290 of Radioactive waste in geologic storage. Fried, S. (ed.). Washington, DC; American Chemical Society (1979).

From American Chemical Society meeting; Miami, FL, USA (10 Sep 1978).

The radionuclide sorption properties of a widely distributed abyssal red clay are being experimentally investigated using standard batch equilibration techniques. These measurements provide data required by the U.S. Seabed Disposal Program to assess the feasibility of emplacing radioactive wastes in sub-seafloor geologic formations. Equilibrium distribution coefficients are generally being evaluated at 4°C as functions of pH and nuclide concentration in solution. Data has been obtained for solutions containing a single sorbing species of either Cs, Rb, Sr, Ba, Ag, Cd, Eu, Gd, Ce, or Pm. Distribution coefficients varied from 10 to 10^4 or 10^5 ml/gm as the nuclide concentration in solution varied from 10^{-2} to 10^{-7} M or less, respectively. These results appear consistent with data for other oceanic sediments and for similar clay minerals found within the continental United States. The distribution coefficients depended little on pH within the range of 6 to 8; however, below pH 2.7 the barium, silver, and europium distribution coefficients were greatly diminished. It appears that the magnitude and behavior of the distribution coefficients result from multiple sorption mechanisms.

40446 Ion-exchange equilibria between montmorillonite and solutions of moderate-to-high ionic strength. Shiao, S.Y. (Oak Ridge National Lab., TN); Rafferty, P.; Meyer, R.E.; Rogers, W.J. pp 297-324 of Radioactive waste in geologic storage. Fried, S. (ed.). Washington, DC; American Chemical Society (1979).

From American Chemical Society meeting; Miami, FL, USA (10 Sep 1978).

Reported are distribution coefficients of alkali metal ions (Cs, K) and alkaline earth ions (Sr, Ca, Ba) and one rare earth (Eu) between montmorillonite in the Na and Ca forms and aqueous solutions of controlled pH, at moderate-to-high salinities. 14 figures. (DLC)

40447 (RFP-Trans—269) New look at the economical disposal of filters contaminated with radioactive aerosols. Sinhuber, D.; Stiehl, H.H.; Schroth, W. (Delbag-Luftfilter G.m.b.H., Berlin (Germany, F.R.)). 1976. No source information available. (CONF-761145—7(trans)). 6p. Dep. NTIS, PC A02/MF A01.

From Seminar on high efficiency aerosol filtration in the nuclear industry; Aix-en-Provence, France (23 Nov 1976).

Aerosol filters impregnated with radioactive aerosols represent a high percentage of the radioactive waste of nuclear plants. The structure of the aerosol filters currently used in air filtration units is antagonistic to economical disposal and space-saving ultimate storage. Aerosol filters need to be redesigned with a view to waste disposal. The criteria of these new designs are as follows: reduction of the space required for aerosol filters used at the same (or even increased) flow rates and with the same efficiency; great reduction of the structural volume of the filter before (or concomitantly with) putting it into the waste container; performance of the following operations on the aerosol filter without contamination: removal, volume reduction, and insertion into the waste container; the smallest possible volume of the aerosol filter after processing for ultimate storage. The present state of the art is applied to the design of aerosol filters which meet the above requirements, and the advantages of such designs as compared to those in present use are described.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 40182, 40431, 40456, 41626, 41628, 41637, 41649, 41650

40448 (CONF-780819—P2, pp 901-915) **Radioiodine detector based on laser induced fluorescence.** Baronavski, A.P.; McDonald, J.R. (Naval Research Lab., Washington, DC). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

A technique is described to measure airborne concentrations of $^{129}I_2$ in nuclear power generation and reprocessing plants. Due to its low specific activity, long half-life, and low energy decay products, radio-counting techniques for ^{129}I are not practical. A laser fluorescence technique based on coincidences between a ^3He-^{20}Ne laser and $^{129}I_2$ in a scrubbed system; at 1 atm of argon and 1 atm air the sensitivities are reduced by factors of 86 and 131.7 respectively. Possible interferences, measurements under flowing conditions, and ultimate sensitivities are discussed. An evaluation of the technique and extension to a portable, real time monitoring instrument for use in the field is given.

40449 (CONF-780819—P2, pp 971-980) **IAEA/NEA activities in the field of gaseous wastes.** Dube, J. (Nuclear Energy Agency, Paris, France); Zabaluev, Y. Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Present and planned radioactive airborne measuring and monitoring practices in some IAEA/NEA Member countries' nuclear facilities are described. Special attention has been given to taking into account the bahavior of air cleaning systems under accidental conditions, as this was of particular importance as demonstrated notably during the Browns Ferry Fire. This information is the basis for defining applicable state-of-the-art methods, advanced technology, and development needs. Measuring and monitoring systems and practices are described for power reactors, reprocessing, waste solidification, uranium and plutonium fabrication facilities, and for incinerator-compactor waste facilities. Information received from Argentina, Australia, Belgium, Canada, Czechoslovakia, Federal Republic of Germany, Hungary, India, Iran, Italy, Japan, Netherlands, Poland, Sweded, Switzerland, United Kingdom, and United States is reported. Operating experience and problems of monitoring systems at these facilities is outlined and some future development requirements defined. As some answers provided new developments in monitoring technology during the last few years, these have been included.

40450 (LBL—8904) **Studies of actinide sorption on selected geologic materials.** Silva, R.J.; Benson, L.V.; Apps, J.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1978. Contract W-7405-ENG-48. 35p. (CONF-780902—19). Dep. NTIS, PC A03/MF A01.

From American Chemical Society meeting; Miami, FL, USA (10 Sep 1978).

Interactions of U, Np, Pu, Am, and Cm with basalt, shale, and granite were studied. The sorption—desorption processes were studied by batch-type technique and gamma counting. Experimental results to date are given and discussed. 11 figures, 8 tables. (DLC)

40451 (NUREG/CR—0629) **Field and modeling study of windblown particles from a uranium mill tailings pile. Interim report.** Schwendiman, L.C.; Sehmel, G.A.; Horst, T.W.; Thomas, C.W.; Perkins, R.W. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1979. Contract EY-76-C-06-1830. 128p. (PNL—2890). Dep. NTIS, PC A07/MF A01.

A field study is reported, showing that for a carbonate-leach-process mill tailings pile in the Grants, New Mexico region much of the residual radioactive constituents in the tailings is found associated with particles 7 μm in diameter and smaller. As the tailings material dries, particle attachment and aggregation occurs with the result that radioactive constituents become associated more with larger particles. Soil samples taken at surface and subsurface on radial lines extending from the tailings pile for 5 miles showed the distribution of radium-226 and other radionuclides in the soil. The radeium-226 deposited on the soil was distributed in such a manner that about 1.6 Ci of randon-222 per day enters the atmosphere from this secondary source. The suspension and transport of particles were studied using an array of sampling towers and wind speed and velocity instrumentation that signaled designated samplers at upwind and downwind locations to operate when wind direction and speed criteria were satisfied. Flux of particles in various size ranges was determined as a function of wind speed. The radionuclide content of airborne particles as a function of particle size was measured for some samplers. A significant fraction of airborne radioactive material is associated with respirable particles. 56 figures, 13 tables

40452 (ORO—4447-089) **Mineral-contributed anion effects on the retention of trivalent actinides in the environment.** Krajewski, T.; Beall, G.W.; Allard, B.; Peterson, J.R. (Oak Ridge National Lab., TN (USA)). 1979. Contract EY-76-S-05-4447. 8p. (CONF-790602—42). Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; Atlanta, GA, USA (3 Jun 1979).

Distribution coefficients are given as a function of pH for americium on dolomite, apatite, anhydrite, and quartz. It is concluded that carbonate- and phosphate-containing minerals can enhance the sorption of trivalent actinides in the ground. (DLC)

40453 (ORO—4447-090) **Sorption of americium on major rock-forming minerals.** Allard, B.; Beall, G.W.; Krajewski, T.; Peterson, J.R. (Oak Ridge National Lab., TN (USA)). 1979. Contract EY-76-S-05-4447. 7p. (CONF-790602—38). Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; Atlanta, GA, USA (3 Jun 1979).

Adsorption of Am(III) on quartz, microcline, albite, anorthite, bytownite, biotite, muscovite, and hornblende was studied as a function of pH. On the basis of the results, the distribution coefficients of trivalent actinides would be in the range 4—7 m^3/kg for granite and 2—6 m^3/kg for basalt for 1-week contact time. 2 figures. (DLC)

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 40182, 40392, 40408, 40433, 40434, 41619, 41620, 41736, 41737, 41738

40454 (DOE/EV—0005/10) **Formerly utilized MED/AEC sites remedial action program. Radiological survey of the former Horizons, Inc., metal handling facility, Cleveland, Ohio. Final report.** Leggett, R.W.; Cottrell, W.D.; Shinpaugh, W.H.; Doane, R.W.; Haywood, F.F.; Johnson, W.M. (Oak Ridge National Lab., TN (USA)). Feb 1979. Contract W-7405-ENG-26. 137p. Dep. NTIS, PC A07/MF A01.

The results of a radiological survey of the former Horizons, Inc., metal handling facility in Cleveland, Ohio, are presented in this report. During the 1940's and early 1950's, two of the three buildings on this site (Buildings B and C) were used for the production of granular thorium metal. The survey included measurements related to the following: fixed and transferable alpha and beta-gamma contamination levels on the surfaces in Buildings B and C and on the roofs of these buildings; external gamma radiation levels at 1 m above the floors and grounds on and near the property; radionuclide concentrations in soil, water, and other materials collected from surfaces and drains inside Buildings B and C, from beneath the floor in Building C, and from outdoor locations on and near the site; and thoron (^{220}Rn) daughter concentrations in the air in Buildings B and C. Elevated concentrations of ^{232}Th, ^{228}Ra, ^{228}Th, and ^{230}Th were found in some samples. Alpha and beta-gamma contamination levels exceeded applicable guideline limits in some areas of Buildings B and C. External gamma radiation levels, approximately 10 times the average background level, were measured at isolated points in and near Building B. Thorium B (^{212}Pb) concentrations in air in Building B were near the Radioactivity Concentration Guide (RCG) level. Most of the elevated radiation levels were found indoors in areas presently used for storage. Outdoors on and near the site, significant radiation levels were found only near the east wall of Building B.

40455 (DOE/EV—0005/14) **Formerly utilized MED/AEC sites remedial action program. Removal of a contaminated industrial waste line, Los Alamos, New Mexico. Final report.** Gunderson, T.C.; Ahlquist, A.J. (comps.). (Los Alamos Scientific Lab., NM (USA)). Apr 1979. Contract W-7405-ENG-36. 69p. Dep. NTIS, PC A04/MF A01.

In 1977 parts of an abandoned industrial waste line (IWL) that carried laboratory or process chemical and radiochemical wastes were removed from Los Alamos Scientific Laboratory property and from the townsite of Los Alamos in north-central New Mexico. Most of the IWL was removed between 1964 and 1967. Some IWL segments in the townsite, which at that time were buried under newly paved roads, were left for removal during future construction projects involving these roads to minimize traffic problems and road damage, and because they posed no public health hazard. In 1977, prior to impending major road construction in several areas, 400 m (1300 ft) of IWL and two IWL manhole structures were removed from Laboratory and Los Alamos County property. Associated soil contamination was removed to levels considered to be as low as practicable. Contaminated or potentially contaminated material was removed to an approved radioactive waste disposal site on Department of Energy property. Full details of the methods, findings, and as-left conditions are documented in this report.

40456 **Biogeochemistry of actinides: a nuclear fuel cycle perspective.** Bondietti, E.A.; Trabalka, J.R.; Garten, C.T.; Killough, G.G. (Oak Ridge National Lab., TN). pp 241-265 of Radioactive waste in geologic storage. Fried, S. (ed.). Washington, DC; American Chemical Society (1979).

From American Chemical Society meeting; Miami, FL, USA (10 Sep 1978).

Through an examination of the comparative behavior of the actinide elements in terrestrial and aquatic food chains, the anticipated accumulation behavior of the transuranium elements by people was described. The available data suggests that Pu, Am, and Cm will not accumulate to a greater degree than U in the skeletons of individuals exposed to environmentally dispersed activity. The nature of the contamination event, the chemical and physical associations in soils and sediments, the proximity to the contamination site - all will influence observed behavior. Because of the establishment of regulatory guidelines for limiting chronic exposure to transuranium elements, research on environmental behavior must address the question of accumulation by people. In the absence of lifetime accumulation data and the paucity of contaminated sites, approaches such as those documented in this paper may aid in understanding and evaluating the hazards of releasing actinide elements to the biosphere.

REGULATIONS

REFER ALSO TO CITATION(S) 40863, 40866, 40867

ACCOUNTABILITY AND SAFEGUARDS

40457 (LA—7551-MS) **Problem statement: international safeguards for a light-water reactor fuels reprocessing plant.** Shipley, J.P.; Hakkila, E.A.; Dietz, R.J.; Cameron, C.P.; Bleck, M.E.; Darby, J.L. (Los Alamos Scientific Lab., NM (USA)). Mar 1979. Contract W-7405-ENG-36. 38p. (SAND—79-0108). Dep. NTIS, PC A03/MF A01.

This report considers the problem of developing international safeguards for a light-water reactor (LWR) fuel reprocessing/conversion facility that combines the Purex process with conversion of plutonium nitrate to the oxide by means of plutonium (III) oxalate precipitation and calcination. Current international safeguards systems are based on the complementary concepts of materials accounting and containment and surveillance, which are designed to detect covert, national diversion of nuclear material. This report discusses the possible diversion threats and some types of countermeasures, and it represents the first stage in providing integrated international safeguards system concepts that make optimum use of available resources. The development of design methodology to address this problem will constitute a significant portion of the subsequent effort. Additionally, future technology development requirements are identified. 8 figures, 1 table.

40458 (LA-UR—79-1022) **Large vehicle portal monitor for perimeter safeguards applications.** Caldwell, J.T.; Atwater, H.F.; Bernard, W.; Bieri, J.M.; Shunk, E.R. (Los Alamos Scientific Lab., NM

(USA)). 1979. Contract W-7405-ENG-36. 8p. (CONF-790430—4). Dep. NTIS, PC A02/MF A01.

From 1. annual symposium on safeguards and nuclear material management; Brussels, Belgium (25 Apr 1979).

We have developed a class of vehicle portal monitors based on shielded 4π geometry neutron counting. we have derived and experimentally verified an analytical expression relating the detection sensitivity of the neutron tunnel vehicle portal monitor to four design parameters of the system. For a given number of neutron detectors, this design achieves one or more orders of magnitude improvement in nuclear materials detection sensitivity over previous vehicle portal monitors.

40459 (LA-UR—79-1023) **New containment and surveillance portal monitor data analysis method.** Henry, C.N.; Pratt, J.C. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 16p. (CONF-790430—3). Dep. NTIS, PC A02/MF A01.

From 1. annual symposium on safeguards and nuclear material management; Brussels, Belgium (25 Apr 1979).

A new containment and surveillance portal monitor data analysis method has been developed. Current approaches use only the data from a single passage and an average background interval for alarm determination. The new method improves performance by summing the counts from many passages for comparison to the expected count, thus improving the statistical accuracy.

40460 (LA-UR—79-1073) **Data analysis for nuclear materials accounting.** Shipley, J.P. (Los Alamos Scientific Lab., NM (USA)). 24 Apr 1979. Contract W-7405-ENG-36. 6p. (CONF-790430—11). Dep. NTIS, PC A02/MF A01.

From 1. annual symposium on safeguards and nuclear material management; Brussels, Belgium (25 Apr 1979).

Materials accounting for special nuclear material in future fuel cycle facilities will draw heavily on sophisticated data-analysis techniques. Decision analysis, which combines elements of estimation theory, decision theory, and systems analysis, can be used to reduce errors caused by subjective data evaluation and to condense large collections of data to a smaller set of more descriptive statistics. The methods and requirements of decision analysis are discussed and illustrated by a conceptual design example of an advanced materials accounting system for a plutonium nitrate-to-oxide conversion facility.

40461 (LA-UR—79-1074) **Modeling and simulation for the design and evaluation of advanced materials accounting systems.** Dayem, H.A. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 9p. (CONF-790430—12). Dep. NTIS, PC A02/MF A01.

From 1. annual symposium on safeguards and nuclear material management; Brussels, Belgium (25 Apr 1979).

Modeling and simulation techniques are used to design and evaluate advanced materials measurement and accounting systems for future nuclear fuel cycle facilities, using dynamic models of process and measurement operations. These techniques are required because operating data from modern facilities are not available. The Los Alamos safeguards modeling and simulation approach is discussed and is illustrated by a simple example.

40462 (PNL—2559) **INSPECT: a package of computer programs for planning safeguards inspections.** Wincek, M.A.; Mullen, M.F. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1979. Contract EY-76-C-06-1830. 130p. (ISPO—58). Dep. NTIS, PC A07/MF A01.

As part of the U.S. program to provide technical assistance to the International Atomic Energy Agency, a package of computer programs was developed for use in planning safeguards inspections of various types of nuclear facilities. The INSPECT software package is a set of five interactive FORTRAN programs which can be used to calculate the variance components of the MUF (Material Unaccounted For) statistic, the variance components of the D (difference) statistic, attribute and variables sampling plans, a measure of the effectiveness of the inspection, and a measurement of the cost of implementing the inspection plan. This report describes the programs and explains how to use them.

40463 (UCRL—81949) **Modelling adversary actions against a nuclear material accounting system.** Lim, J.J.; Huebel, J.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Apr 1979. Contract W-7405-ENG-48. 6p. (CONF-790430—13). Dep. NTIS, PC A02/MF A01.

From 1. annual symposium on safeguards and nuclear material management; Brussels, Belgium (25 Apr 1979).

A typical nuclear material accounting system employing double-entry bookkeeping is described. A logic diagram is used to model the interactions of the accounting system and the adversary when he attempts to thwart it. Boolean equations are derived from the logic diagram; solution of these equations yields the accounts and records through which the adversary may disguise a SSNM theft and the collusion requirements needed to accomplish this feat. Some technical highlights of the logic diagram are also discussed.

ADMINISTRATIVE AND REGULATORY

REFER ALSO TO CITATION(S) 40860, 41736, 41737, 41738

40464 (INIS-mf—4594) **Town and Country Planning (Windscale and Calder Works) Special Development Order 1978.** (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1978. 3p. Dep. NTIS (US Sales Only), PC A02/MF A01.

This Order grants planning permission subject to conditions for the erection of a plant for the reprocessing of spent uranium oxide fuels that support site services on land owned by British Nuclear Fuels Limited at the Windscale and Calder Works, Cumbria. It was made under the Town and Country Planning Act 1971 and deals with the 'non-nuclear aspects of this development'. Installation and operation of the plant will require a nuclear site licence under the Nuclear Installations Act 1965, and any discharge of radioactive waste will require an authorisation under the Radioactive Substances Act 1960.

40465 (INIS-mf—4599) **Ministerial Decree of 3 March 1978 approving the general conditions of the third party liability insurance policy for operators of nuclear installations and the general conditions of insurance policies for third party liability for transport of nuclear materials.** (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1978. 1p. (In Italian). Dep. NTIS (US Sales Only), PC A02/MF A01.

This Decree by the Ministry for Industry, Commerce and Crafts and the Ministry for transport of Italy was made in implementation of Section 2 of the Decree No. 519 by the president of the Republic of 2 May 1975 amending Section 15 to 24 of Act No. 1860 of 31 December 1962 on the Peaceful Uses of Nuclear Energy. This present Decree approves the general conditions of third party liability insurance policies for operators of nuclear installations and for transport of radioactive materials.

40466 (INIS-mf—4605) **Order of 11 October 1977 on general safety measures applicable to fluids, radioactive waste and irradiated and non-irradiated fuels in large nuclear installations.** (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1978. 1p. (In French). Dep. NTIS (US Sales Only), PC A02/MF A01.

This Order by the Minister of Industry, Commerce and Crafts and the Minister of Labour was made in implementation of Section 40 of Decree No. 75-306 of 28 april 1975 on the protection of workers against the hazards of ionizing radiation in large nuclear installations. It lays down the safety measures to be taken as regards construction of the installation to limit radioactive dispersal and exposure of workers. The Order specifies the characteristics of the piping and vessels as well as the materials to be used for construction of such vessels and piping. The radioactive fluids must be contained in especially designed pipes and vessels and transport of radioactive substances within installations must be carried out with the approval of the person responsible for radiation protection as defined in Decree No 75-306. Finally all possible measures must be taken to eliminate risks of criticality, in particular when the quantity of fissile materials likely to be assembled is likely to exceed the limits fixed by Order of 25 January 1867.

40467 (INIS-mf—4612) **Windscale Inquiry - A U.K. Exercise in Nuclear Regulation.** Bolter, H. (British Nuclear Fuels Ltd., London). 1978. 7p. (CONF-780584—3). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on regulating nuclear energy; Brussels, Belgium (16 May 1978).

This paper describes the Public Inquiry opened on 14 June 1977 concerning extenssion of the Windscale plant and the events preceding it. Four issues were considered: the implications of the proposed development for public safety; those for other aspects of the national interest; those of plant construction and operation for the environment: the measures that could be adopted under existing U.K. legislation, particularly under the Radioactive Substances Act 1960 to control waste disposal, and under the Nuclear Installations Act 1965 to provide for the safety of operations, and finally, other implications for the locality.

FUSION FUELS

REPROCESSING

REFER ALSO TO CITATION(S) 41263

TRANSPORT AND STORAGE

40468 (BNL—50929) **Tritium storage development. Progress report No. 15, January—March 1978.** Colombo, P.; Johnson, R. (Brookhaven National Lab., Upton, NY (USA)). 1978. Contract EY-76-C-02-0016. 19p. Dep. NTIS, PC A02/MF A01.

Two hydriding—dehydriding runs were made with zirconium sponge on an engineering scale for application to retrievable tritium storage systems. The dehydriding rates were low in comparison to hydriding rates. An overall hydrogen recovery of 35% was achieved after 16 hours at 500°C. At 600°C, the overall hydrogen recovery was 66% after 48 hours. Hydriding rates were obtained for titanium rod at 450 and 525°C. The maximum reaction rates for an initial system pressure of 705—709 torr were 0.026 and 0.40 Cm^3 of H_2 at STP/cm^2-min at 450 and 525°C, respectively. Increasing the initial system pressure to 1863 torr increased the maximum reaction rate to 1.04 cm^3 of H_2 at STP/CM^2-min at 525°C. In general, these rates are comparable to the rates obtained with zirconium sheet.

WASTE MANAGEMENT

40469 (CONF-780819—P1, pp 142-166) **Modification and testing of the Sandia Laboratories Livermore tritium decontamination systems.** Gildea, P.D.; Birnbaum, H.G.; Wall, W.R. (Sandia Labs., Livermore, CA). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Sandia Laboratories, Livermore, has put into operation a new facility, the Tritium Research Laboratory. The laboratory incorporates containment and cleanup facilities such that any tritium accidentally released is captured rather than vented to the atmosphere. This containment is achieved with hermetically sealed glove boxes that are connected on demand by manifolds to two central decontamination systems called the Gas Purification System (GPS) and the Vacuum Effluent Recovery System (VERS). The primary function of the GPS is to remove tritium and tritiated water vapor from the glove box atmosphere. The primary function of the VERS is to decontaminate the gas exhausted from the glove box pressure control systems and vacuum pumps in the building before venting the gas to the stack. Both of these systems are designed to remove tritium to the few parts per billion range. Acceptance tests at the manufacturer's plant and preoperational testing at Livermore demonstrated that the systems met their design specifications. After preoperational testing the Gas Purification System was modified to enhance the safety of maintanance operations. Both the Gas Purification System and the Vacuum Effluent Recovery System were performance tested with tritium. Results show that concentration reduction factors (ratio of inlet to exhaust concentrations) much in excess of 1000 per pass have been achieved for both systems at inlet concentrations of 1 ppM or less.

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

40470 (PNL—2930) **List of DOE radioisotope customers with summary of radioisotope shipments FY 1978.** Burlison, J.S.; Laidler, R.I. (comps.). (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1979. Contract EY-76-C-06-1830. 50p. Dep. NTIS, PC A03/MF A01.

The purpose of the document is to list DOE's radioisotopes production and distribution activities by its facilities at Argonne National Laboratory; Pacific Northwest Laboratory; Brookhaven National Laboratory; Hanford Engineering Development Laboratory; Idaho Operations Office; Los Alamos Scientific Laboratory; Mound Facility; Oak Ridge National Laboratory; Savannah River Laboratory; and UNC Nuclear Industries, Inc.

PHYSICAL ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 41386

40471 **Method for separation and enrichment of lithium isotopes by laser.** Yamashita, M.; Kashiwagi, H. (to Ministry of International Trade and Industry). US Patent 4,149,077. 10 Apr 1979. Priority date 27 Aug 1976, Japan, 8p.

The element lithium has strong absorption lines near 6707.84 A and 3232.61 A and possesses specific isotope shifts at the respective absorption lines. With the aid of a laser capable of controlling the oscillation spectral width accurately to 0.01 A, the isotopes of this element are separated from each other by irradiating lithium atomic beam with a laser beam tuned to the absorption line of either of the isotopes, ^6Li and ^7Li, for thereby selectively exciting the isotope, ionizing the excited isotope along by irradiation with a laser beam having one photon energy enough to pump it from the excited state to the ionized state and separating the ionized isotope from the un-ionized isotope by means of a mass-filter.

HEAVY WATER PRODUCTION

40472 **Process for the exchange of hydrogen isotopes between streams of gaseous hydrogen and liquid water.** Butler, J.P.; Rolston, J.H.; den Hartog, J.; Molson, F.W.R. (to Atomic Energy of Canada Ltd.). US Patent 4,143,123. 6 Mar 1979. Priority date 25 Jun 1976, Canada, 22p.

A process for the exchange of hydrogen isotopes between streams of gaseous hydrogen and liquid water is described, wherein the streams at a temperature in the range 273 to 573°K are brought into contact with one another and a catalytically active mass comprising an inherently hydrophobic, porous, polytetrafluoroethylene matrix and partially platinized carbon particles dispersed throughout the whole of the porous polytetrafluoroethylene matrix in the weight ratio of 1:1 to 3:1 of polytetrafluoroethylene to partially platinized high surface area carbon particles. The inherently hydrophobic, porous polytetrafluoroethylene matrix allows the catalytically active metal to catalyze the hydrogen isotope exchange reaction between hydrogen gas and water vapor in the presence of liquid water while retarding loss of activity of the catalytically active metal by contact of the metal catalyst with liquid water. This catalyzed chemical isotope exchange proceeds simultaneously with isotope exchange from water vapor to liquid water by a non-catalyzed, physical evaporation, and condensation exchange reaction.

RADIATION SOURCES

OTHER INDUSTRIAL USES

REFER ALSO TO CITATION(S) 41177

40473 (SAND—79-0182) **Sandia irradiator for dried sewage solids.** (Sandia Labs., Albuquerque, NM (USA)). Feb 1979. Contract EY-76-C-04-0789. 192p. (CONF-7810165—). Dep. NTIS, PC A09/MF A01.

From Sandia irradiator for dried sewage solids seminar and dedication; Albuquerque, NM, USA (18 Oct 1978).

Separate abstracts have been prepared for the individual papers presented at the seminar. (TFD)

40474 (SAND—79-0182, pp 15-20) **Keynote address: Sandia irradiator for dried sewage solids.** Roser, H.E. (U.S. Department of Energy, Albuquerque, NM). Feb 1979.

From Sandia irradiator for dried sewage solids seminar and dedication; Albuquerque, NM, USA (18 Oct 1978).

The paper summarizes, from the Department of Energy viewpoint, the history and status of the work on irradiated dried sewage solids. It was pointed out that the program, whose official title is Beneficial Use of Radioactive Waste, seeks to combine the two national problems of radioactive waste and the accumulation of sewage sludge to provide a new national resource. This new resource, a sterilized sludge product, would have a market value of $25 to $75 per ton for land use and up to $100 per ton as an animal feed supplement. The ultimate goal of this program, as with DOE's other energy technology programs, is the transfer of a new technology to private industry.

40475 (SAND—79-0182, pp 53-64) **Licensing and regulatory considerations for cesium-137 irradiators.** Bassin, N. (U.S. Nuclear Regulatory Commission, Washington, DC). Feb 1979.

From Sandia irradiator for dried sewage solids seminar and dedication; Albuquerque, NM, USA (18 Oct 1978).

The review of applications for use of irradiators involves two aspects: (1) the review of the design of the ^{137}Cs sources for adequacy of the containment and the design of the irradiator for adequacy of radiation shielding; and (2) the review of the user's radiation safety program for operation of the irradiator. The information needed to determine adequacy of the sources which will be used in irradiators is discussed. The parameters which need to be considered in the review of the irradiator for adequacy of the design are described. The application which would have to be submitted by a municipality for possession and use of an irradiator must include training and experience of personnel, instrumentation, facilities and equipment, and the radiation safety program for operation of the irradiator. Consideration needs to be given to organization of the

prospective licensee's organization as it relates to radiation safety control. The involvement of Agreement States (those states which have assumed regulatory control over the possession and use of radioactive materials from the NRC) is also described.

40476 (SAND—79-0182, pp 65-76) **Constraints to increased sludge utilization.** Pound, C.E.; Bory, L.D. (Metcalf & Eddy, Inc., Palo Alto, CA). Feb 1979.

From Sandia irradiator for dried sewage solids seminar and dedication; Albuquerque, NM, USA (18 Oct 1978).

The management and disposition of municipal sewage sludge is a growing problem as secondary treatment plants are completed to meet Clean Water Act standards. The prohibition of ocean dumping, the increased cost and difficulty to secure and operate sludge landfills, and the high energy costs of dewatering and incineration should all contribute to an increase in land application. However, land application and other beneficial use alternatives, such as give away/sale, account for only 20% of the 12 m/day tons of sludge produced nationally. This result can in part be attributed to public health, institutional, and legal constraints on implementing land application systems. Public health constraints include contaminants in sludge which may pose a risk to human health. Much current controversy about the safety of applying sludge to agricultural land on which food chain crops are grown focuses on heavy metals, especially cadmium. But proposed federal and state regulation of cadmium concentrations in sludge, at levels where human health risk has not been demonstrated, may limit utilization by land application. State operating rules and other administrative controls over sludge application are among the institutional constraints. Since land is an essential element in a land application system, securing adequate and suitable land involves legal constraints. Involuntary acquisition and zoning procedures can delay and frustrate land application programs. Securing indemnity insurance for possible damage to land to which sludge is applied has also been an obstacle to implementation of utilization programs.

40477 (SAND—79-0182, pp 123-130) **Composting sewage sludge.** Epstein, E. (Energy Resources Co., Inc., Cambridge,MA). Feb 1979.

From Sandia irradiator for dried sewage solids seminar and dedication; Albuquerque, NM, USA (18 Oct 1978).

Sewage sludge is predominantly organic matter containing domestic and industrial wastes. The inefficiency of the waste water treatment to destroy pathogens and stabilization of odor-producing volatile organic compounds necessitates further treatment before sludge can be used as a soil amendment or fertilizer. Composting, which is the rapid biological decomposition of the sludge organic matter is an excellent method of sludge stabilization. During the process, volatile organics are decomposed and many of the pathogens destoyed. The low cost of the process and its flexibility with respect to labor and capital makes the system highly attractive to municipalities. A major problem facing large urban waste water treatment facilities is the distribution or marketing. The light weight of the material, expensive hauling costs, and low fertilizer value reduce its attractiveness to the agricultural sector. Thus, the greatest market is for horticultural purposes, sod, nurseries, greenhouses, parks, and reclamation areas. The major potential benefits of irradiating compost as a means of further disinfection are: (1) elimination of any health hazard; (2) increase of market potential, i.e., providing more market outlets to distribute the material; (3) compliance with state and federal health regulations; and (4) enhancement of the economics of composting as a result of utilizing compost in speciality products commanding a higher value.

40478 (SAND—79-0182, pp 131-146) **Sludge utilization and potential isotope source quantities in Europe.** Vidal, P.E. (SCERDTI, Lyon, FR). Feb 1979.

From Sandia irradiator for dried sewage solids seminar and dedication; Albuquerque, NM, USA (18 Oct 1978).

The European Community has sludge management problems which are essentially similar to those of the United States. However, the utilization potential, the public response to treatment needs, and the isotope utilization outlook differ from those of the United States. A study by the European Society for Nuclear Methods in Agriculture (ESNMA) is discussed. The study covers 97% of Western Europe and looks at sludge utilization and potential ^{137}Cs resources fom reprocessed reactor fuel through 1990. The plans for a French Beneficial Uses Program is also discussed.

40479 (SAND—79-0182, pp 147-162) **Pilot plant study.** Morris, M.E. (Sandia Labs., Albuquerque, NM). Feb 1979.

From Sandia irradiator for dried sewage solids seminar and dedication; Albuquerque, NM, USA (18 Oct 1978).

Approximately 18 months ago Sandia Laboratories undertook the design and fabrication of an eight ton per day dry sewage sludge irradiator. The facility is intended: (1) to function as a high gamma dose rate research facility, (2) to be a test-bed for the unique electrical and mechanical components to be used in larger facilities, (3) to fulfill the formal requirements of a pilot plant so that design and construction of a demonstration facility could proceed, and (4) to provide accurate data based on operating experience for the Environmental Impact Assessment (EIA) and the Safety Analysis Report (SAR) for a larger facility. Design objectives and constraints are presented as well as summaries of thermal and radiation calculations. Safety features included in the design are described.

40480 (SAND—79-0182, pp 163-170) **Generic demonstration plant study (A/E package).** Molzen, D.F. (Molzen—Corbin & Associates, Albuquerque, NM). Feb 1979.

From Sandia irradiator for dried sewage solids seminar and dedication; Albuquerque, NM, USA (18 Oct 1978).

Molzen—Corbin & Associates, Albuquerque, New Mexico, under contract to Sandia Laboratories, has prepared preliminary drawings, descriptive material and a scale model of the demonstration plant. This information will be made available to A/E firms to assist them in the preparation of proposals for complete construction plans and specifications. The four categories for which preliminary work has been prepared consist of structural work, mechanical work, electrical work, and cost estimates. In addition, preliminary specifications, including a written description of the facility consisting of mechanical electrical systems and operations, a description of the safety features, the basic design criteria, three-dimensional sketches, and a scale model of the design have been prepared. The preliminary drawings indicate the required minimum wall thicknesses, overall dimensions and the necessary layout of the removable concrete blocks and slabs required for radiation protection and control.

40481 (SAND—79-0182, pp 171-188) **Licensing and environmental assessment requirements for a sludge irradiation program.** DiMento, L. (NUS Corp., Rockville, MD). Feb 1979.

From Sandia irradiator for dried sewage solids seminar and dedication; Albuquerque, NM, USA (18 Oct 1978).

The Nuclear Regulatory Commission's (NRC) licensing requirements and the circumstances in which an environmental impact statement may be required under the National Environmental Policy Act (NEPA) are described. Three Federal agencies may participate in the program—the NRC, the Department of Energy, and the Environmental Protection Agency—and a possible scenario for their involvement in the environmental impact assessment process is described. Many states also have environmental requirements similar to those of NEPA and, therefore, an environmental impact analysis may also be required for state approval. The state of California was the first to pass an environmental policy act, and it is one of the most comprehensive of all state acts. A brief description is provided as an example of what the sludge irradiation program may encounter at the state level. Finally, a short discussion of the Department of Transportation's regulations governing the transport of hazardous material is presented. Although these regulations will be of minimal concern to the user of the radiation source, they assist in the understanding of the overall regulatory process.

ISOTOPIC POWER SUPPLIES

40482 (ORNL/TM—6826) **Post-test analysis of components from selenide isotope generator modules M-7, M-15, and M-18.** Wei, G.C.; Keiser, J.R.; Crouse, R.S.; Allen, M.D.; Schaffhauser, A.C. (Oak Ridge National Lab., TN (USA)). May 1979. Contract W-7405-ENG-26. 112p. Dep. NTIS, PC A06/MF A01.

Several critical components removed from SIG (Selenide Isotope Generator) thermoelectric modules M-7, M-15C, M-15D, and M-18 were examined. These modules failed to show the predicted stability and conversion efficiency. Understanding the degradation and identifying means for preventing it necessitated detailed post-test examinations of key parts in the modules. Steel springs, which provided pressure for contacts at the hot and cold ends of P- or N-legs, relaxed more than expected. Beryllium oxide insulators had dark deposits that caused electrical shorts. The $GdSe_{1.49}$ N-leg exhibited cracking. The $(Cu,Ag)_2Se$ P-leg lost weight or sublimed excessively in module M-7 and more than expected in the other modules.

DESIGN AND FABRICATION

40483 (LA—7854-PR) **General-Purpose Heat Source Project, Space Nuclear Safety Program and Radioisotopic Terrestrial Safety Program. Progress report, March 1979.** Maraman, W.J. (comp.). (Los Alamos Scientific Lab., NM (USA)). May 1979. Contract W-7405-ENG-36. 55p. Dep. NTIS, PC A04/MF A01.

The formal monthly report covers the studies related to the use of $^{238}PuO_2$ in radioisotopic power systems carried out for the Advanced Systems and Materials Production Division by the Los Alamos Scientific Laboratory. The three programs involved are: General-Purpose Heat Source Development; Space Nuclear Safety; and Radioisotopic Terrestrial Safety.

40484 (N—79-10526) **MINI-BRU/BIPS 1300 we dynamic power conversion system development: executive summary.** (AiResearch Mfg. Co., Phoenix, AZ (USA)). Sep 1978. Contract NAS3-18517. 25p. NTIS PC A02/MF A01.

The status of the Brayton Isotope Power System (BIPS) is summarized. A 1200 We ground development unit was built and tested in a 0.000010 torr vacuum environment. Peformance mapping and 1000 hours of proof of concept system testing were completed. Specific components, primarily turbocompressor/alternator and recuperator performed according to predictions, thus achieving the design goal of 25 percent net power conversion efficiency. The system was fabricated from superalloy (Hastelloy-X and Waspaloy) thus placing it entirely within current state-of-the-art technology. The system could be flyable in the early 1980's pending flight qualification.

HYDROGEN

PRODUCTION

THERMOCHEMICAL PROCESSES

40485 **Multi-step chemical and radiation process for the production of gas.** Gomberg, H.J. (to Texas Gas Transmission Corp.). US Patent 4,140,603. 20 Feb 1979. Filed date 7 Apr 1976. 6p.

A multi-step chemical and radiation process for the production of gas which includes mixing water and chlorine gas, heating the mixture to a temperature of about 800°C. to produce hydrogen chloride and oxygen and subjecting the hydrogen chloride to radiation to produce hydrogen and chlorine gas. The process also includes the recycling of the resulting halogen into the basic process.

40486 **Multi-step chemical and radiation process.** Gomberg, H.J. (to Texas Gas Transmission Corp.). US Patent 4,140,601. 20 Feb 1979. Filed date 16 Mar 1976. 8p.

A process is claimed which utilizes radiation energy, preferably that obtained from a fusion reaction and which includes selecting starting chemical materials having at least two molecules such as calcium bromide and water which contain as a part thereof a desired produce H_2, a by-product O_2 and which chemically form an active material HBr that may be dissociated by radiation. A two-step process permits the radiolytically dissociated Br to react with residual molecules to form and recycle the starting material $CaBr_2$. A combination of thermochemical and radiolytic reactions such as available in nuclear reactions therefore produces a greater yield of a desired end product such as hydrogen, also producing a by-product such as oxygen from a low cost expendable source material such as water, and reforms the starting material. Also the process provides for convenient separation of the desired end products.

STORAGE

REFER ALSO TO CITATION(S) 41191, 41296

CHEMISORPTION

REFER ALSO TO CITATION(S) 41263, 41322

UNDERGROUND

40487 (SAND—78-8272) **Applications analysis of fixed site hydrogen storage.** Iannucci, J.J.; Robinson, S.L. (Sandia Labs., Livermore, CA (USA)). May 1979. Contract EY-76-C-04-0789. 23p. Dep. NTIS, PC A02/MF A01.

The potential applications and requirements for fixed site storage in a scenario of wide spread hydrogen use are examined and quantified. An envisioned hydrogen production/distribution/end-use cycle is scrutinized to identify the storage needs for both continuous and intermittent sources including solar. The most pressing need for storage is found to be at the distribution point, in concurrence with current natural gas practice. Caverns and similar underground storage techniques are shown to be the most promising modes due to their low cost relative to all other options examined. Since a large volume of natural gas storage is presently in service, a pressing need to develop fixed site hydrogen storage technology (beyond the conversion of this underground storage to hydrogen) has not been identified.

TRANSPORT

REFER ALSO TO CITATION(S) 40487, 41114

INDUSTRIAL AND COMMERCIAL USE

REFER ALSO TO CITATION(S) 41183

OTHER SYNTHETIC AND NATURAL FUELS

REFER ALSO TO CITATION(S) 41114

HYDROCARBON FUELS

REFER ALSO TO CITATION(S) 40184, 41120

40488 (AD-A—060081) **Naval Air Systems Command-Naval Research Laboratory Workshop on Basic Research Needs for Synthetic Hydrocarbon Jet Aircraft Fuels held at Naval Research Laboratory, Washington, D.C., June 15 and 16, 1978.** (Naval Air Systems Command, Washington, DC (USA)). 1978. 205p. NTIS PC A10/MF A01.

The Workshop emphasized the technical aspects of synthetic jet fuels. The purpose was to examine what is known about synfuels, highlight current research programs, and suggest areas of basic research which are important to the future use of synthetic hydrocarbon fuels in jet aircraft.

PREPARATION

CHEMICAL SYNTHESIS

REFER ALSO TO CITATION(S) 40107

40489 (LBL—8975, pp 45-46) **Catalytic reactions on clean surfaces.** Hansen, R.S. (Iowa State Univ., Ames). Feb 1979.

In Heterogeneous catalysis research meeting.

40490 **Operation of a tube wall methanation reactor.** Pennline, H.W.; Schehl, R.R.; Haynes, W.P. (US Dep of Energy, Pittsburgh Energy Technol Cent, Pa). *Ind. Eng. Chem., Process Des. Dev.;* **18**: No. 1, 156-162(Jan 1979).

The design and operation of a PDU-scale tube wall methanation system are discussed. The tube wall reactor was constructed from a stainless steel pipe with a surrounding jacket. The inside surface of the tube was flame sprayed with Raney nickel catalyst for 14 ft of length. The catalyst coating was activated by leaching with a caustic solution. A liquid coolant in the outer shell of the reactor removed the heat of methanation and maintained the system at near isothermal conditions. Exposure velocity and recycle ratio were varied during the run. Concentration and temperature profiles were periodically measured along the length of the catalyst bed. Catalyst performance, methane production, deactivation, and other results are presented for the test which was terminated after 1179 h on stream.

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 40500, 40501, 40538, 40543

40491 (DOE-tr—162) **Biogas. (Reference materials edition). Volume One.** [nd]. No source available. 216p. Dep. NTIS, PC A10/MF A01.

Reference material (most of it translated from American and European sources) on the production and use of biogas (methane) from organic wastes is compiled. An introduction gives an overview of the development of the use of biogas in China. The topics discussed in the reference articles include the microbiology of anaerobic digestion and methane production, biogas collection, anaerobic digestion in waste recycling system, use of agricultural and animal wastes, methane-driven devices for household use, and effect of temperature on methane production. (JSR)

40492 Influence of inoculation and pH on marsh gas fermentation. *Hua Hseuh Tung Pao;* No. 6, 6-10(23 Nov 1976). (In Chinese).

This article reports a research on the influence of inoculation and pH on marsh gas fermentation. It was found that: 1) inoculation with 10 to 30% of old marsh gas fermentation liquor will accelerate both the fermentation process and the speed of methane production, while the results will be more prominant if fresh fermentation preparations are also added and 2) the optimal pH for the acid producing fermentation stage is 7.5, and that for the marsh gas producing stage is 6.8 to 7.5. It is suggested that air oxidation is an effective and economical technique for raising the pH prior to the peak of fermentation.

40493 (DOE-tr—167) **Rural use of biogas.** 1976. Translation source information not available. 209p. Dep. NTIS, PC A10/MF A01.

A manual on the production and use of biogas in the rural areas of China is presented. The importance of biogas production for improving the agricultural level is stressed and its properties are explained. The basic principles in the construction and maintenance of a biogas plant are given. Detailed explanations are then given for constructing and repairing various models of biogas tanks. Methods of using biogas and safety considerations in its production and use are outlined. Data are given on various construction materials, so that locally available materials can be used. (JSR)

ALCOHOL FUELS

40494 Catalytic synthesis of methanol from CO/H_2. I. Phase composition, electronic properties, and activities of the Cu/ZnO/M_2O_3 catalysts. Herman, R.G. (Lehigh Univ., Bethlehem, PA); Klier, K.; Simmons, G.W.; Finn, B.P.; Bulko, J.B. *J. Catal.;* **56**: No. 3, 407-429(15 Mar 1979).

The low pressure methanol synthesis catalysts Cu/ZnO, Cu/ZnO/Al_2O_3, and Cu/ZnO/Cr_2O_3 were found to contain a new compound identified as a Cu/sup I/ solution in ZnO, which is also an active component of the above catalysts. Combined x-ray diffraction, optical, and XPS-Auger studies are presented that describe the formation, electronic structure, and surface composition of these catalysts. In particular, the surface of the working catalyst is free of carbon, both in the presence and absence of CO_2 in the feed gas. A synthesis mechanism is proposed whereby the Cu/sup I/ centers nondissociatively chemisorb and activate carbon monoxide and the ZnO surface activates hydrogen. Catalyst deactivation in CO/H_2mixture is explained as the reduction of Cu/sup I/ to inactive copper metal, while the rate enhancing effect of O_2, H_2O, and CO_2 is due to the maintenance of an oxidation potential high enough to keep the copper in the active Cu/sup I/ state. No special pore distribution or presence of crystalline phases such as spinels is necessary for selectivity of the Cu/ZnO catalyst to the formation of methanol. 10 figures, 63 references, 4 tables.

PROPERTIES

40495 (UCRL—82434) **Modeling of flame properties of methanol.** Westbrook, C.K.; Dryer, F.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Mar 1979. Contract W-7405-ENG-48. 12p. (CONF-790520—1). Dep. NTIS, PC A02/MF A01.

From 3. international alcohol fuels technology; Asilomar, CA, USA (28 May 1979).

Many fuel utilization concepts involve detailed information on flame properties. Processes such as ignition, flame propagation, flame quenching, pollutant formation and others all require the type of fundamental understanding which numerical modeling can help to provide. Computational flame modeling, using a recently developed detailed chemical kinetic reaction mechanism for methanol oxidation, provides a means of obtaining a great deal of data on the structure and propagation of methanol flames. The effects of stoichiometry, pressure, unburned gas temperature, and trace constituents such as water vapor on flame speed and flammability have been determined and are discussed in this paper. In each distinct physical regime, different elementary reactions tend to dominate the reaction mechanism, and in each case the interactions between fluid mechanical and chemical kinetic processes are responsible for the observed behavior.

PREPARATION

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 40501, 41724

40496 Shallow-depth sedimentation of yeast cells. Walsh, T.J.; Bungay, H.R. (Rensselaer Polytechnic Inst, Troy, NY). *Biotechnol. Bioeng.;* **21**: No. 6, 1081-1084(Jun 1979).

Shallow-depth sedimentation is a reliable, inexpensive answer for recycle of yeast for ethanol production. As a design exercise, a plate settler was specified for 1 x 10^8 gal broth/day, which might be typical for fermentors for fuel-grade ethanol. This settler would have plates 305 cm long, 1 cm apart, with 45° inclination. For a residence time of 2 hr, the settler volume would be 88000 gal. This seems enormous, but the cost would be low because stresses on the plates are so slight that cheap, flimsy construction materials would be suitable.

PROPERTIES

REFER ALSO TO CITATION(S) 40489

PREPARATION

REFER ALSO TO CITATION(S) 40501

SOLID WASTE FUELS

REFER ALSO TO CITATION(S) 40238, 40540, 40541, 40543, 41067, 41120

40497 (HCP/C—4101) **Near-term potential of wood as a fuel.** (Department of Energy, Washington, DC (USA)). Jan 1979. Contract EG-77-C-01-4101. 71p. Dep. NTIS, PC A04/MF A01.

The forest products industry appears to be the most likely candidate for using wood as an energy source in the near-term. Although the industry is approximately 40 percent energy efficient, the remainder of its energy is obtained from gas and oil. Sufficient additional wood is available to replace all the oil and gas used by the industry. The sources are cited. Technologies available to expand the near-term use of wood fuel include direct combustion, low-Btu gasification in the presence of air, pyrolysis to char, liquid fuel, and low-Btu gas in the absence of air, and densification. Life-cycle costs were evaluated for these technologies. Incentives in increase the use of wood fuel in the near term are identified. An appendix lists systems manufacturers, architecture and engineering firms, and users.

40498 (N—79-10528) **An evaluation of wood-waste energy conversion systems.** Levelton, B.H. (Levelton (B.H.) and Associates Ltd., Vancouver, British Columbia (Canada)). 31 Mar 1978. 199p. NTIS PC A09/MF A01.

The British Columbia Wood Waste Energy Co-Ordinating Commission was formed to evaluate the potential increased use of wood waste as an energy source in British Columbia. As part of this program, the committee commissioned a study of the technology available for recovering energy from wood waste and evaluation of the merits of various systems available for energy recovery. The terms of reference of the study may be summarized as follows: (1) identify potential applications in the forest-products industry for wood-waste fuels to replace fossil fuels; (2) identify and assess the relative merits of the various classes of systems for wood energy conversion; and (3) identify and evaluate specific existing commercial and pilot-scale systems for wood-energy conversion with emphasis on all possible end uses of each system.

40499 (NBS-GCR—78-149) **Analysis of fire reports on file in the Massachusetts State Fire Marshal's Office relating to wood and coal heating equipment.** Shelton, J.W. (Department of Energy, Washington, DC (USA). Div. of Fossil Fuel Utilization; National Bureau of Standards, Washington, DC (USA)). Nov 1978. Contract EA-77-A-01-6010. 11p. Dep. NTIS, PC A02/MF A01.

An analysis of solid-fuel related fires reported by local fire departments to the Massachusetts State Fire Marshal's Office from late 1977 through June 1978 indicates that of the fires attributed to specific causes, roughly 3/4 were attributed to unsafe installations, and about 1/4 were attributed to unsafe operation/maintenance. In less than 2 percent of the fires was the cause attributed to defects or poor design in the heating appliance itself. Thus, to the extent that the local fire department reports are complete and reliable, it appears that attention to installation, operation and maintenance is what has the most potential for reducing fires.

40500 (NP—23694) **Retrospective search on combustion and pyrolysis of wood and wood waste.** (Institute for Industrial Research and Standards, Dublin (Ireland). Technical Information Div.). Jul 1977. 49p. Dep. NTIS, PC A03/MF A01.

This annotated bibliography covers the following: general aspects - economics and feasibility studies; processes and equipment; wood wastes; charcoal; and pyrolysis of wood-chemical studies. (MHR)

40501 (SAN—0115-T3) **Mission analysis for the federal fuels from biomass program. Volume IV. Termochemical conversion of biomass to fuels and chemicals.** Kohan, S.M.; Barkhordar, P.M. (SRI International, Menlo Park, CA (USA)). Jan 1979. Contract EY-76-C-03-0115-131. 179p. Dep. NTIS, PC A09/MF A01.

The thermochemical conversion of biomass feedstocks generally denotes technologies that use elevated temperatures to convert the fixed carbon content of biomass materials to produce other, more useful energy forms. Examples are combustion to produce heat, steam, electricity, or combinations of these; pyrolysis to produce gas (low- or intermediate-Btu), pyrolytic liquids and chemicals, and char; gasification to produce low or intermediate Btu gas (and, from IBG, additional products such as SNG, ammonia, methanol, or Fischer-Tropsch liquids); and liquefaction to produce heavy fuel oil or, with upgrading, lighter-boiling liquid products such as distillates, light fuel oils, or gasoline. This section discusses the selection of the feedstock used in the analysis of thermochemical conversion technologies. The following sections present detailed technical and economic evaluations of biomass conversion to electricity and steam by combustion, SNG by gasification and methanation, methanol by gasification and synthesis, oil by catalytic liquefaction, oil and char by pyrolysis, and ammonia by gasification and synthesis. The conversion options were reviewed with DOE for approval at the start of the project.

HYDRO ENERGY

RESOURCES AND AVAILABILITY

40502 (DOE/ID/01776—1) **Feasibility study for the addition of a hydroelectric unit at Max Starcke Park Dam for city of Seguin, Seguin, Texas.** (Brown and Root, Inc., Houston, TX (USA)). Dec 1978. Contract EW-78-F-07-1776. 47p. Dep. NTIS, PC A03/MF A01.

A feasibility study was performed for the addition of a hydroelectric power plant at the Max Starcke Park Dam on the Guadalupe River in Seguin, Texas. This study showed that an additional hydroelectric generating plant at this location is economically justified and that a 500 kW plant with two identical 250 kW open flume type units should be installed. (LCL)

SITE GEOLOGY AND METEOROLOGY

40503 (DOE/ID/1760—1) **Potential hydroelectric power Mora Canal Drop. Final report.** Willer, D.C. (Tudor Engineering Co., San Francisco, CA (USA)). Dec 1978. EW-78-F-07-1760. 114p. Dep. NTIS, PC A06/MF A01.

The feasibility of installing a hydroelectric power plant on the Mora Canal Drop site in Idaho was studied. It was recommended that a 1900 kW unit be installed to generate 8,113,000 kWh per year. The project should cost approximately $1.8 million. The generating cost would be between 20.3 and 22.2 mills/kWh. A local utility has offered to buy all power produced at 26 mills/kWh. No adverse environment, safety, or socio-economic effects are foreseen. (LCL)

PLANT DESIGN AND OPERATION

REFER ALSO TO CITATION(S) 40502

ECONOMICS AND MANAGEMENT

REFER ALSO TO CITATION(S) 40502, 40503

40504 (DOE/ET/28310—1) **Cost of controls for small hydroelectric plants or river systems. Final report.** Frick, P.A.; Alexander, G.C. (Oregon State Univ., Corvallis (USA). Dept. of Electrical and Computer Engineering). Feb 1979. Contract EG-77-S-07-1690. 142p. Dep. NTIS, PC A07/MF A01.

The general control principles for low-head hydro installations and, in particular, differences with conventional hydro plants are emphasized. Treating the flow-release mechanism through the turbine as a simple adjustable orifice, two models were derived to depict the dynamic behavior of a dam of arbitrary geometrical shape. Two specific trapezoidal structural examples were used to characterize the difference in behavior of low-head and conventional hydroelectric dam sites. As almost all low-head plants would require the use of a propellor-type turbine, the study was restricted to the analysis of both the theoretical and empirical behavior of Kaplan-type turbines. Flow control is accomplished in such cases by either adjustable wicket gates, adjustable propellor blade angle, or both. Small hydro plants operate essentially by two modes. For Mode I, the flow release rate is automatically adjusted to match the inflow rate, thus maintaining a constant head. Mode II operation requires a considerably more sophisticated controller to maintain a constant power setting at reasonably high efficiency. Very tight control of both head and flow rate is required and, except for cases where very stable inflow rates are guaranteed, it is possible that a microcomputer would be required to perform this function. In comparing the fully automated on site control vs remote control alternatives, no clear picture emerges on a mere cost basis. In all the discussions the use of conventional turbine-related equipment was assumed with the exception of shaft-speed transducers where the use of optical shaft encoders is strongly recommended. It is the authors' opinion that hydraulic servo motors cannot be economically or reliably replaced as wicket-gate and propellor-blade-angle controllers, even in small turbines. A complete linerarized per unit dynamic model was developed to depict the behavior of a hydroelectric plant.

SOLAR ENERGY

REFER ALSO TO CITATION(S) 41119

40505 (CONF-7805162—P1) **Proceedings of the solar energy consumer protection workshop: opening and final plenary sessions. Volume I.** (Florida Solar Energy Center, Cape Canaveral (USA)). Mar 1979. 209p. Dep. NTIS, PC A10/MF A01.

From Solar Energy Consumer Energy workshop; Atlanta, GA, USA (3 May 1978).

The Florida Solar Energy Center began a project in 1977 to identify means to improve residential consumer confidence in active solar systems which, when implemented, would assist in speeding the use of solar energy. This project called for an assessment of potential problems of solar consumers, identification of available consumer protection mechanisms that might address those problems, and an evaluation of the effectiveness of those mechanisms for solar industry and consumer needs in the immediate future. This workshop was held to evaluate the effectiveness of mechanisms for protection of solar consumers and their potential impact on the development of a healthy, competitive solar industry. Major topics discussed in four workshop sessions include standards setting, testing, certification, labeling, trade licensing laws and training programs, building codes, consumer information, and education. The opening and final sessions were convened in plenary form. Following an introductory presentation by Marvin Yarosh, conference chairman, an overview of solar heating and cooling applications and technology was given by Professor John Yellott. Dr. Dennis Schiffel presented a paper entitled: Solar Market Penetration - Market Projection. The briefing on the FSEC project was given by Rajesh Talwar and Polly Craighill, to complete the opening plenary session. Summaries are also given in this Volume I of the 4 workshop sessions covering the major topics selected for discussions. Volume II of the proceedings contains the edited versions of the four individual workshops. (MCW)

RESOURCES AND AVAILABILITY

REFER ALSO TO CITATION(S) 41116

40506 (COO—4470-13) **Coastal-inland solar radiation difference study. Quarterly conference report.** Bach, W.D. Jr. (Research Triangle Inst., Research Triangle Park, NC (USA)). Oct 1978. Contract EG-77-C-02-4470. 14p. Dep. NTIS, PC A02/MF A01.

The southeastern North Carolina Coastal Plain was selected as the study area. Sea breeze circulations are nearly an every day occurrence along the Onslow Bay coast of North Carolina beginning in late May and extending into October. That circulation has been observed as early as February and as late as November. Typically the inflow portion of the circulation extends 40 to 50 km inland, but this varies depending upon the intensity and direction of the synoptic flow of the land-sea temperature differences. This area also has excellent coverage by meteorological radar and meteorological satellites. The area is also relatively free of industrial pollution sources which might affect or complicate the measurements. The objectives of this research program will be obtained by a successful completion

of three principal program elements, data acquisition, calibration and quality assurance, and data analysis and interpretation.

40507 (LA-UR—79-673) **Potential prediction needs in support of energy systems.** Blake, R.L. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 7p. (CONF-790413—3). Dep. NTIS, PC A02/MF A01.

From International solar-terrestrial predictions workshop; Boulder, CO, USA (23 Apr 1979).

Utilization of existing and potential new energy systems involves interactions between these systems and the natural environment. Basic research is needed to define the interaction processes of significance. Thereafter long range solar-terrestrial predictions will be important to national policy on proper control of energy systems. A few selected examples are given to show that energy systems are tied to global solar-terrestrial systems.

40508 (LBL—8778) **Spectral measurements of infrared sky radiance.** Berdahl, P.; Martin, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jan 1979. Contract W-7405-ENG-48. 13p. (CONF-790118—3). Dep. NTIS, PC A02/MF A01.

From 3. national passive solar conference; San Jose, CA, USA (11 Jan 1979).

Recent measurements of the thermal infrared radiance of the sky are presented, showing the spectral distribution of radiation from the zenith. Samples of the data are compared with computer calculations for similar meteorological conditions. Computer calculations are based on the computer program LOWTRAN 3B. In general, the data confirm expectations that Tucson, with clear skies and dry air, is a good location for infrared radiative cooling systems. For an idealized selective surface at 25°C the average cooling rate would have been 89 w/m^2 in Tucson (8/14/78 to 10/5/78), and 65 w/m^2 in San Antonio (9/21/78 to 10/6/78). If this idealized selective surface were allowed to cool down, it would reach an average temperature of -21°C in Tucson and -7°C in San Antonio.

ECONOMICS

REFER ALSO TO CITATION(S) 40510

40509 **Econometric analysis of concentrators for solar cells.** Roy, A.S. (Oak Ridge Assoc Univ, Tenn). *Sol. Energy;* 21: No. 5, 371-375(1978).

When concentrating collectors are used with photovoltaic solar cells, the cost of the generated electricity is controlled by the concentrator cost. This enables the use of highly efficient cells and collectors of high concentration ratios, thereby reducing both the cell and noncell cost components per unit generated electricity. Coal analyses indicate the significance of distinguishing between the cell-cost and the noncell cost-components. A generalized model is formulated for correlating the electricity cost. The model enables the economic assessment of various concentrator-cell system and the evaluation of the sensitivity of the cost of the produced electrical energy to various possible technological improvements. Optimization and the setting of a spectrum of target goals for cells and collectors are thus made possible. An example is included showing projected minima of generated electricity at concentration ratios between 4 and 400.

ENVIRONMENTAL, LEGAL, AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 41579

40510 (COO—4546-11) **Problems encountered by lending institutions and appraisers with respect to solar-equipped buildings. Final report of innovative research program subtask, December 1977—September 1978.** Kress, G.J. (Colorado State Univ., Fort Collins (USA). Solar Energy Applications Lab.). Oct 1978. Contract EG-77-S-02-4546. 21p. Dep. NTIS, PC A02/MF A01.

It was proposed to assess the overall attitudes of Colorado lending institutions towards making loans for construction of solar equipped buildings. A second objective was to identify what problems appraisers have in placing values on solar equipped buildings. Information needed was obtained through mail surveys of 132 banks and 103 appraisers responding. (MHR)

40511 (IS-M—191) **Overview of environmental issues in solar heating and cooling and agricultural and industrial process heat.** Hodges, L. (Ames Lab., IA (USA)). 1978. Contract W-7405-ENG-82. 3p. (CONF-781109—28). Dep. NTIS, PC A02/MF A01.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Environmental issues in solar heating and cooling and agricultural and industrial process heat are listed. Work on materials, toxicity, fire hazards of heat transfer fluids, and waste disposal is mentioned. (MHR)

40512 (ORNL/TM—6913) **Decentralized Solar Energy Technology Assessment Program: research plan.** Bronfman, B.H.; Schweitzer, M.; Carnes, S.A.; Peelle, E.; Samuels, G. Jr.; Wilbanks, T.J. (Oak Ridge National Lab., TN (USA)). May 1979. Contract W-7405-ENG-26. 53p. Dep. NTIS, PC A04/MF A01.

The Decentralized Solar Energy Technology Assessment Program (TAP) is a program sponsored by the Office of Solar, Geothermal, Electric and Storage Systems, Department of Energy (DOE). The major purpose of the program is to assess the social, political, institutional and life-style impacts of the widespread adoption of decentralized solar technology. This document describes the major components and presents the research plan for the TAP. Responsibilities, milestones and deliverables for all components are identified where applicable.

40513 (UCRL—81013) **Department of Energy's solar technology transfer program: the Lawrence Livermore Laboratory experience.** Newkirk, H.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 Jan 1979. Contract W-7405-ENG-48. 5p. (CONF-781235—5). Dep. NTIS, PC A02/MF A01.

From Symposium on commercialization of solar and conservation technologies; Miami Beach, FL, USA (11 Dec 1978).

The Lawrence Livermore Laboratory (LLL) under the direction of the Department of Energy's (DOE's) Solar Technology Transfer Program (STTP) has designed and implemented a regionalized solar commercialization outreach program. Primary target audiences in Arizona, California, Hawaii and Nevada include architects, builders, lenders, contractors, plumbers, manufacturers, distributors as well as educational institutions, state and local offices, and library systems. The experience gained during this initial LLL/STTP program will be of value to the coming solar technology transfer and commercialization activities now being planned by the Solar Energy Research Institute (SERI), regional SERI's, the Energy Extention Service, and the National Solar Heating and Cooling Information Center.

40514 **Analysis of California's solar tax incentives.** Rains, D.W. (Univ. of California, Davis). pp 943-954 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Much attention has recently been focused on the great potential for solar energy to offset increasing demand for fossil fuels in California. Numerous legislative proposals have been forwarded to make that potential a reality. This paper utilizes an extended benefit-cost analysis to evaluate the impact of legislation that extends tax credits to purchasers of solar-energy devices in California. It is automatically assumed that the benefits derived from thousands of solar installations will far out-weigh the costs in terms of millions of dollars in state-revenue losses. The question that must be addressed, however, is whether solar tax incentives will, in fact, stimulate the projected rapid acceleration of solar energy use in California over the next three years.

SOLAR ENERGY CONVERSION

REFER ALSO TO CITATION(S) 41357

PHOTOVOLTAIC CONVERSION

REFER ALSO TO CITATION(S) 40548, 41195, 41203, 41210, 41211, 41347

40515 (ANL/EES-TM—23) **Economic and demographic issues related to deployment of the Satellite Power System: (SPS).** Baldwin, T.E.; Hill, L.G.; Santini, D.J.; Stenehjem, E.J. (PRC Energy Analysis Co., McLean, VA (USA)). Oct 1978. Contract W-31-109-ENG-38. 71p. Dep. NTIS, PC A04/MF A01.

Growth in energy consumption has stimulated interest in exploitation of renewable sources of electric energy. One technology that has been proposed is the Satellite Power System (SPS). Before committing the U.S. to such a large program, the Department of Energy and the National Aeronautics and Space Administration are jointly participating in an SPS Concept Development and Evaluation Program. This white paper on industrial and population relocation is part of the FY 1978 preliminary evaluation of related socio-economic issues. Results of four preliminary assessment activities are documented, namely: review existing literature dealing with industrial location, attendant population migration, and the role of electricity availability and pricing as factors influencing economic move-

ments; identify economic and demographic issues relating to the deployment of SPS; consider the potential significance of these sociodemographic impacts in terms of expected public acceptance by appropriate interest groups; and recommend additional study needs and the most advantageous approaches to these studies. The conclusion of this preliminary assessment is that FY 1979 study should be concentrated in four assessment areas: (1) rectenna siting strategies, (2) expected effects of marginal and average-cost pricing on industrial and population relocation, (3) future impact of rectennae siting, and (4) responsiveness of industry to locate facilities according to the availability and cost of electricity. Long-term research should address the question of whether SPS will contribute to the centralization or decentralization of economic activity and society.

40516 (COO—4094-32) **Field tests of photovoltaic power systems.** Pope, M.D.; Matlin, R.W. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 1979. Contract EY-76-C-02-4094. 10p. (CONF-790305—5). Dep. NTIS, PC A02/MF A01.

From ASME gas turbine closed-cycle session; San Diego, CA, USA (11 Mar 1979).

Field test experience gained at existing photovoltaic test sites is discussed. These sites include a 25 kW peak power system at Mead, Nebraska, a 12 kW peak array at MIT/Lincoln Laboratory, a 1.6 kW peak PV power system at the Chicago Museum of Science and Industry, and several small (~ 100 watts peak) arrays located in various urban and rural sites. Data are given on failures which have occurred in the field and on the frequency of unscheduled outages. Also, information is presented concerning the environmental extremes to which the systems have been exposed. Operating experience gained from these projects is discussed in the contexts of storage, reliability, safety and cost. Finally, some projects which are currently in the design stage are discussed. This includes a 100 kW peak power system which will serve the entire electric load for the Natural Bridges National Monument in Utah, and a 10 to 20 kW peak power system which will power a small AM radio station located at a site yet to be determined in the North Central/North east region of the U.S.

40517 (COO—4094-40) **PV module performance at Mead, Nebraska test site. Quarterly report for October 1, 1978—December 31, 1978.** Forman, S.E.; Themelis, M.P. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 1 Apr 1979. Contract EY-76-C-02-4094. 33p. Dep. NTIS, PC A03/MF A01.

The Department of Energy has set a 20-year lifetime goal for terrestrial photovoltaic modules. Massachusetts Institute of Technology's Lincoln Laboratory, in its capacity as a Photovoltaic Field Tests and Applications Center, has established various experimental test sites in the United States ranging in size from 0.1 to 25 kW of peak power. These sites serve as test beds for photovoltaic system components and include modules from several manufacturers. This report summarizes the activities of the Materials, Processes and Testing Laboratory of the Solar Photovoltaic Project during a three-month (10/1/78—12/31/78) period. Particular attention is given to testing and analysis of solar modules from the Mead, Nebraska site, which contains a 25-kW array. A trip to the site was made, where various testing and inspection procedures were followed, in order to ascertain the physical and electrical degradation which had occurred in modules. In addition, several modules were removed for more detailed testing and inspection in the Laboratory. The results of both the field testing and laboratory analyses are reported here.

40518 (DOE/JPL/1012—2) **Project quarterly report-8, January 1978—March 1978.** (California Inst. of Tech., Pasadena (USA)). 1978. Contract EX-76-A-29-1012. 72p. (JPL-PUB—79-14). Dep. NTIS, PC A04/MF A01.

Progress made by the Low-Cost Silicon Solar Array Project during the period January through March 1978 is described. Task reports on silicon material processing, large-area silicon sheet development, encapsulation materials testing and development, project engineering and operations, and manufacturing techniques, plus the steps taken to integrate these efforts are included.

40519 (DOE/JPL/954328—11) **Development of an accelerated test design for predicting the service life of the solar array at Mead, Nebraska. Quarterly report.** Gaines, G.B.; Thomas, R.E.; Noel, G.T.; Shilliday, T.S.; Wood, V.E.; Carmichael, D.C. (Battelle Columbus Labs., OH (USA)). 6 Feb 1979. Contract NAS-7-100-954328. 52p. Dep. NTIS, PC A04/MF A01.

Economic viability requires that photovoltaic arrays should have a service life of 20 years or longer. Qualification and performance tests indicate that presently available photovoltaic modules provide acceptable performance at the time of installation. This study is being conducted as part of a program to develop and validate an accelerated test plan that can be used to predict the useful service life of present and future solar arrays. Previously a methodology was developed for designing an accelerated test program incorporating trade-offs between the cost of each test and its value in reducing the variance in the life prediction for that array. The objective of the present study is to apply this methodology to develop an accelerated test plan to predict the service life of the 25-kW photovoltaic array installed near Mead, Nebraska. Potential long-term degradation modes for the two types of modules in the Mead array have been determined and judgments have been made as to those environmental stresses and combinations of stresses which accelerate the degradation of the power output. Hierarchical trees representing the severity of effects of stresses (test conditions) on eleven individual degradation modes have been constructed and have been pruned of tests judged to be nonessential. Composites of those trees have been developed so that there is now one pruned tree covering eight degradation modes, another covering two degradation modes, and a third covering one degradation mode. These three composite trees form the basis for selection of test conditions in the final test plan which is now being prepared.

40520 (DOE/JPL/954331—4) **Silicon materials task of the low cost solar array project (Phase III). Effect of impurities and processing on silicon solar cells. Twelfth quarterly report.** Hopkins, R.H.; Davis, J.R.; Blais, P.D.; Rohatgi, A.; Campbell, R.B.; Rai-Choudhury, P.; McCormick, J.R.; Mollenkopf, H.C. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center; Dow Corning Corp., Midland, MI (USA)). Oct 1978. Contract NAS-7-100-954331. 48p. Dep. NTIS, PC A03/MF A01.

This is the first quarterly report for Phase III of a program to define the effects of impurities, various thermochemical processes and any impurity-process interactions on the performance of terrestrial silicon solar cells. The projected Phase III effort falls in five areas: (1) cell processing studies, (2) completion of the data base and impurity-performance modeling for n-base cells, (3) extension of p-base studies to include contaminants likely to be introduced during silicon production, refining or crystal growth, (4) anisotropy effects, and (5) a preliminary study of the permanence of impurity effects in silicon solar cells. The dominant activity during this quarter was the growth of ingots. Fourteen Czochralski ingots were produced including several base line ingots, p-base ingots for processing studies and large diameter ingots for the anisotropy investigation. Data on cellular breakdown in four of the heavily doped ingots was consistent with prior predictions. Besides the crystal growth a detailed deep level spectroscopic analysis of the electrical activity of Ti in silicon was performed and modeling studies of impurity behavior were extended.

40521 (DOE/JPL/954373—8) **Heat exchanger method - ingot casting fixed abrasive method - multi-wire slicing. Phase II. Silicon sheet growth development for the Large Area Sheet Task of the Low Cost Solar Array Project. Quarterly progress report No. 4 for July 1—September 30, 1978.** Schmid, F.; Khattak, C.P. (Crystal Systems, Inc., Salem, MA (USA)). 15 Oct 1978. Contract NAS-7-100-954373. 66p. Dep. NTIS, PC A04/MF A01.

Solar cells fabricated from HEM cast silicon have yielded up to 15% conversion efficiencies. This has been achieved in spite of using unpurified graphite parts in the HEM furnace and without optimization of material or cell processing parameters. Molybdenum retainers have prevented SiC formation and reduced carbon content by 50%. The oxygen content of vacuum cast HEM silicon is lower than typical Czochralski grown silicon. Impregnation of 45 μm diamonds into 7.5 μm copper sheath has shown distortion of the copper layer. However, 12.5 μm and 15 μm copper sheath can be impregnated with 45 μm diamonds to a high concentration. Electroless nickel plating of wires impregnated only in the cutting edge has shown nickel concentration around the diamonds. This has the possibility of reducing kerf. The high speed slicer fabricated can achieve higher speed and longer stroke with vibration isolation. This machine will be used for slicing 3" and 4" diameter workpieces.

40522 (DOE/JPL/954374—7) **Slicing of silicon into sheet material. Silicon sheet growth development for the large area silicon sheet task of the Low Cost Silicon Solar Array Project. Tenth quarterly report, June 19—October 27, 1978.** Fleming, J.R. (Varian Associates, Lexington, MA (USA). Lexington Vacuum Div.). 20 Nov 1978. Contract NAS-7-100-954374. 38p. Dep. NTIS, PC A03/MF A01.

The limits of blade tolerances are defined. The standard blades are T-2 thickness tolerance: T-O blades are unacceptable. Further testing is necessary to demonstrate feasibility or infeasibility of T-1 blades. Good results have been obtained by using a slurry fluid consisting of mineral oil and a lubricity additive. Cost would be about $0.25 per gallon per run, 1/4 of the cost goal. Adjustments of the formulation and fine tuning of the cutting process with the new fluid are necessary. Test results and consultation indicate that the blade breakage encountered with water based slurries is unavoidable. Two full capacity (974 wafer) runs have been made on the large prototype saw. Both runs resulted in extremely low yield, however, the reasons for the low yields were lack of proper technique rather than problems with machine function. Finally, the tests on the effect of amount of material etched off of an as-sawn wafer on solar cell efficiency have been completed. The results agree with previous

work at JPL in that the minimum material removed per side that gives maximum efficiency is on the order of 10 μm.

40523 (DOE/JPL/954471—3) **Novel duplex vapor-electrochemical method for silicon solar cells. Quarterly progress report No. 10, 1 May 1978—31 July 1978.** Kapur, V.K.; Nanis, L.; Sancier, K.M.; Sanjurjo, A. (SRI International, Menlo Park, CA (USA)). 1978. Contract NAS-7-100-954471. 39p. Dep. NTIS, PC A03/MF A01.

The reactor to produce silicon by the reaction between gaseous SiF_4 and liquid sodium was scaled up to produce 100 g of silicon per batch. To recover the silicon from the large volume of products of this reaction, the aqueous leaching process was scaled up to treat up to 2-kg batches of reaction product. Rapid leaching was determined to be effective in minimizing loss of silicon due to oxidation. About 95% of the weight of silicon believed to be present in the reaction products was recovered. An alternative approach to recover the silicon from the reaction products is to heat the products above the melting temperature of silicon. Results from preliminary melting experiments are very promising, in that two separate phases of Si and NaF were obtained. Examination of the frozen melt shows that the silicon agglomerated as large globules of greater density than NaF. The NaF prevents the silicon from wetting and reacting with the graphite and permits the granular Si particles to agglomerate when molten.

40524 (DOE/JPL/954471—8) **Novel duplex vapor-electrochemical method for silicon solar cells. Quarterly progress report No. 11 for August 1—October 31, 1978.** Kapur, V.; Sancier, K.M.; Sanjurjo, A.; Leach, S.; Westphal, S.; Bartlett, R.; Nanis, L. (SRI International, Menlo Park, CA (USA)). 1978. Contract NAS-7-100-954471. 54p. Dep. NTIS, PC A04/MF A01.

A simplified feed system for the Na used in the Na-SiF_4 reactor has been developed. Solid Na is added directly to the reaction zone, thus avoiding the handling of liquid Na. The reduction of sodium fluosilicate with sodium metal has been proven to be an alternative path for the production of high purity silicon. Batches containing about 1 kg of silicon have been produced with a purity similar to the products obtained with the SiF_4-Na reaction. During the leaching process to recover silicon from the products of the SiF_4-Na reaction, hydrogen is evolved. Kinetic studies indicate that the hydrogen evolution may be a diffusion-limited process. Mechanism studies are continuing; at present, it appears that small amounts of sodium are incorporated in the silicon, although the type of inclusion is uncertain. During leaching, the resulting local regions of high alkalinity could promote the oxidation of silicon. Studies of silicon separation by the melting of the reaction product have been continued. Analyses have been made of the purification of the processes of melting and solidification. Reaction products from both the SiF-Na reaction and the Na-SiF-Na reaction have been successfully separated by melting to yield silicon in bulk form.

40525 (DOE/JPL/954521—8) **Integral glass encapsulation for solar arrays. Quarterly progress report No. 9 for August 23—November 22, 1978.** Younger, P.R. (Spire Corp., Bedford, MA (USA)). Dec 1978. Contract NAS-7-100-954521. 22p. Dep. NTIS, PC A02/MF A01.

This is the ninth quarterly report under a program to develop integral glass encapsulation for solar cell arrays. The status of development of the techniques for employing electrostatic bonding in conjunction with terrestrial solar cells is described. Functioning solar modules have been made by electrostatic bonding (ESB) in several configurations, including ESB total glass encapsulation, ESB/PVB hybrid encapsulation, and ESB front/organic back systems. All have shown no noticeable degradation, electrically or mechanically, in accelerated testing. These tests show that electrostatic bonding will be fully capable of meeting the specification of a 20-year lifetime in a cost-effective manner.

40526 (DOE/JPL/954865—4) **Array Automated Assembly Task, Low Cost Silicon Solar Array Project: Phase 2. Quarterly technical report No. 4 for July—September 1978.** Rhee, S.S.; Jones, G.T.; Allison, K.L. (Sensor Technology, Inc., Chatsworth, CA (USA)). 1978. Contract NAS-7-100-954865. 56p. Dep. NTIS, PC A04/MF A01.

An automated processing sequence is being investigated in seventeen process groups which each encompass a number of processing steps. An indepth analysis of the process steps incorporated within the individual process groups is currently being performed, and each group is discussed. These process groups are: cell test data acquisition, plasma etching of resist, laser trimming and holing operation, wafer surface preparation, laser scanning inspection, wafer printing, low pressure vapor metal deposition, silicon nitride AR coating, wafer plating, soldering coating and flux removal, cell handling for module construction, laser trimming and holing automation, cell and module test and data storage, module construction study, spray on dopants, conveyorized dopant diffusion, and module model fabrication and materials. A final SAMICS report will be submitted at the conclusion of the overall process analysis.

40527 (DOE/JPL/954898—3) **Phase 2, automated array assembly, Task IV, low-cost silicon solar array project. Quarterly report No. 3.** (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA (USA)). Jul 1978. Contract NAS-7-100-954898. 44p. Dep. NTIS, PC A03/MF A01.

Functional 3-inch diameter reference cells were fabricated using conventional processes consisting of: $POCl_3$ diffusion, electroless nickel plating, solder dipping, and evaporated SiO AR coating. Both flash and texture-etched surface wafers were used. The flash-etched cells yielded output efficiencies of 10.3%, whereas the texture-etched cells were considerably lower. Other flash and texture-etched cells were processed by ^{31}P ion implantation 25 keV and 3 x 10^{15} ions/cm^2, thermal annealing, and electroless nickel plating, resulting in 7% AM1 efficiencies. Problems were experienced in the nickel plating process which contributed to poor ohmic contact adherence and the resulting low efficiencies. Laser annealing was performed by Quantronix with an Nd:YAG laser on our texture-etched, flash-etched, and polished ion implanted wafers. A programmed X-Y positioning stage was used for precise traversing across the wafer surface. Best results of 7.3% AM1 efficiencies were attained on .5 x .5 cm size cells with polished surfaces. These cells had evaporated Ti/Ag contacts but not sintered nor AR coated. I/sub sc/ of these small cells was 5 ma. This represents a 27 ma/cm^2 output based on active area only, and compares with 32 ma/cm^2 for a conventionally processed cell of 11% AM1 efficiency. A cost analysis was prepared which reflects potential cost savings of laser annealing over thermal annealing in excess of $35 million. This savings is due to a projected cell efficiency improvement of 2%, resulting in reduced quantities of cells for the 500 megawatt capability. Spraying of tantalum solutions was performed on 2 x 4 cm space cells using the Zicon Autocoater. Cells were electrically tested at the outset in the as-received condition with SiO AR coating.

40528 (DOE/JPL/954977—2) **Quantitative analysis of defects in silicon. Silicon sheet growth development for the Large Area Silicon Sheet Task of the Low Cost Solar Array Project. Quarterly progress report No. 2 for June 1—September 30, 1978.** Natesh, R.; Smith, J.M.; Qidwai, H.A. (Materials Research, Inc., Centerville, UT (USA)). 1978. Contract NAS-7-100-954977. 51p. Dep. NTIS, PC A04/MF A01.

The various steps involved in obtaining quantitative information of structural defects in crystalline silicon samples are described. The following procedures are discussed: (1) chemical polishing; (2) chemical etching; (3) automated image analysis of samples on the QTM 720 System; and (4) preliminary discussion of data.

40529 (DOE/JPL/955055—1) **Silicon solar cell process development, fabrication, and analysis. First quarterly report, August 28, 1978—December 31, 1978.** Minahan, J.A. (Spectrolab, Inc., Sylmar, CA (USA)). 1978. Contract NAS-7-100-955055. 29p. Dep. NTIS, PC A03/MF A01.

A program plan, baseline process, measurement program and quality control plan have been generated as enunciated by the contract. Cutting operations have been completed on the Wacker Silso silicon sheet material. The first fabrication run of Wacker Silso polycrystalline silicon into solar cells by the baseline process has been completed. Average conversion efficiency for solar cells fabricated by the baseline process from Wacker Silso sheet and measured at air mass zero was 10.4%, compared with the control cells, fabricated from single crystal CZ silicon, whose average conversion efficiency was 12.2%.

40530 (SAN—1286-3) **Amorphous silicon solar cells. Quarterly report No. 3, January 1—March 31, 1977.** Carlson, D.E. (RCA Labs., Princeton, NJ (USA)). Apr 1977. Contract EY-76-C-03-1286. 37p. Dep. NTIS, PC A03/MF A01.

A detailed study of the photoluminescence, photoconductivity, and infrared absorption of discharge-produced a-Si has shown the optimum substrate temperature to be ~ 300 to 350°C. The photovoltaic properties of a-Si solar cells are also optimized by deposition of the a-Si in this temperature range. The out-diffusion of hydrogen apparently creates defect states such as dangling bonds when the substrate temperature exceeds approx. 350°C. The concentration of bonded hydrogen increases as the power is increased in a rf(E) electrodeless discharge in SiH_4. The dark conductivity and photoconductivity decrease significantly as the power increases. In general, both the dark conductivity and the photoconductivity of a-Si films depend on the thermal and optical history. Exposure to light causes the dark conductivity and photoconductivity to decrease; these changes can be reversed by annealing for a few minutes at temperatures ~ > 150°C. Amorphous-silicon solar cells have been fabricated with fill factors as high as 0.674. These cells exhibited space charge densities of 1.5 x 10^{15}/cm^3 in the dark and 2.5 x 10^{16}/cm^3 in AM1 illumination. Although the best conversion efficiency to date is ~ 5.5%, the product of the best values of V/sub oc/, J/sub sc/, and the factor yields ~ 8%.

40531 (SAN—1459-1) **Cadmium sulfur—copper sulfide heterojunction cell research. Technical progress report No. 1, 30 September 1977—30 November 1977.** (Lockheed Missiles and Space Co., Palo Alto, CA (USA). Lockheed Palo Alto Research Lab.). 22 Dec 1977. Contract EG-77-C-03-1459. 7p. Dep. NTIS, PC A02/MF A01.

The program objective is to investigate and evaluate the application of post-magnetron reactive sputtering to the production of solar-cell quality thin films of CdS/Cu_2S for large-scale terrestrial photovoltaic energy conversion. The usual start-up activities such as ordering equipment, materials, and components and constructing or modifying required equipment were undertaken. Preliminary CdS reactive sputtering deposition studies and completion and testing of an H_2 ambient annealing furnace were reported. (MHR)

40532 (SAN—1459-3) **Cadmium sulfide—copper sulfide heterojunction cell research. Technical progress report No. 3, 1 March 1978—31 May 1978.** (Lockheed Missiles and Space Co., Palo Alto, CA (USA). Lockheed Palo Alto Research Lab.). 30 Jun 1978. Contract EG-77-C-03-1459. 37p. (LMSC—D626523). Dep. NTIS, PC A03/MF A01.

The program objective is to investigate and evaluate the application of cylindrical-post magnetron reactive sputtering to the production of solar cell quality thin films of CdS/Cu_2S for large scale terrestrial photovoltaic energy conversion. Cominco American has encountered difficulties in maintaining the desired 6-9's purity while casting Cd, Cd—Zn, and Zn sputtering targets over the nickelplated copper mandrels which are used to provide strength to the overall assembly. A major activity has been a systematic study of Cu/sub x/S coatings deposited by reactive sputtering Cu in Ar—H_2S gas mixtures at various injection rates (partial pressures) of H_2S. The coatings were deposited on borosilicate glass substrates at substrate temperatures of about 35°C and 130°C. The coatings were analyzed with respect to electrical, optical, and structural characteristics. Van der Pauw and temperature dependence of resistivity measurements were made on selected films. Optical constants were obtained from transmission and reflection measurements. Structural and compositional measurements were made using x-ray diffraction, scanning electron microscopy, microprobe, and x-ray energy spectroscopy. For H_2S partial pressures greater than 1.4 mtorr, it was found that two types of Cu/sub x/S films, i.e., high resistivity and low resistivity, can be deposited on glass substrates using T/sub s/ as the primary control paratmeter. Geneally, the high resistivity films contain Cu-rich nodules which appear to be growing out of the film. Both chalcocite and djurleite phases are present in some films, with djurleite predominant in the low resistivity films.

40533 (TID—28707) **Fabrication and characterization of ITO/Silicon solar cells. Annual progress report, March 1, 1977—March 1, 1978.** DuBow, J. (ed.). (Colorado State Univ., Fort Collins (USA). Dept. of Electrical Engineering). Mar 1978. Contract EG-77-S-02-4524. 160p. Dep. NTIS, PC A08/MF A01.

Fabrication procedures and instrumentation for indium tin oxide on silicon solar cells are discussed. Descriptions of analysis, instrumentation, and experimental works related to cell characterization are presented. A theoretical description of cell characteristics and operation is presented. A description of the work on the physical and chemical structure of the cell is given. An economic model of device production and an estimate of the availability of indium are presented. (MHR)

40534 **Thin-film GaAs solar cells with grain-boundary edge passivation.** Ghandhi, S.K.; Borrego, J.M.; Reep, D.; Hsu, Y.; Pande, K.P. (Electrical and Systems Engineering Department, Rensselaer Polytechnic Institute, Troy, New York 12181). *Appl. Phys. Lett.;* 34: No. 10, 699-701(15 May 1979).

Solar cells built on polycrystalline gallium arsenide usually have very leaky reverse characteristics and low open circuit voltage. Both these problems arise from the effect of the Schottky diode made on the grain boundary, which shunts the active Schottky solar cell and deteriorates its performance characteristics. Selective anodization techniques have been used to provide an insuating barrier over the grain boundary in order to passivate it. Leakage current reduction of five to six decades has been achieved by this method. In this letter we describe the electrical and photovoltaic characteristics of devices made by this technique. We report, for the first time, a simulated AM1 conversion efficiency of 5.45% on thin-film (8.6 μm) polycrystalline GaAs cells with no antireflection coating, fabricated on molybdenum substrates by the simultaneous pyrolysis of trimethylgallium and arsine in hydrogen.

40535 **Operation of the semiconductor-insulator-semiconductor solar cell: Experiment.** Shewchun, J.; Dubow, J.; Wilmsen, C.W.; Singh, R.; Burk, D.; Wager, J.F. (Division of Engineering, Brown University, Providence, Rhode Island 02912). *J. Appl. Phys.;* 50: No. 4, 2832-2839(Apr 1979).

We have reported on the theory of semiconductor-insulator-semiconductor (SIS) solar cells in a previous publication. In this paper, the fabrication and properties of indium tin oxide/p-Si single-crystal solar cells will be described. The ITO is deposited by the ion-beam sputtering method. Best photovoltaic devices are obtained when the composition of indium tin oxide (ITO) is 91 mole% and 9 mole% SnO_2. The device properties as a function of the ITO composition will be described. The thickness and the composition of the oxide-silicon interface is critical for device performance. The existence of a thin interfacial layer is demonstrated by Auger spectroscopy. The effect of temperature on device performance and the spectral response are compared with the theory. The SIS model accurately matches the major trends observed in experimental nITO/p-Si solar cells.

40536 **Comment on "A simple measurement of absolute solar cell efficiency".** Dalal, V.L.; Rothwarf, A. (Institute of Energy Conversion, University of Delaware, Newark, Delaware 19711). *J. Appl. Phys.;* 50: No. 4, 2980-2981(Apr 1979).

In a recent paper, Shay et al. have described a simple indirect method for measuring absolute cell efficiency based upon using low-light-level quantum-efficiency measurements. We show in this paper that such an indirect method can lead to erroneous results. The error can arise because of at least four physical mechanisms: infrared quenching, recombination-center saturation, trapping-enhanced interface field, and Dember plasma field effects. A simple method to check for these effects is described.

40537 **Efficient solar cell with an intermediate wavelength conversion for operation with concentrators.** Alferov, Z.I.; Andreev, V.M.; Garbuzov, D.Z.; Egorov, B.V.; Larionov, V.R.; Rumyantsev, V.D.; Fedorova, O.M. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Tech. Phys. Lett. (Engl. Transl.);* 4: No. 9, 455(Sep 1978).

Voltage-current characteristics of layered gallium arsenide-aluminium arsenide photocells with an intermediate wavelength conversion are reported. It is shown that such photocells with photolithographic contact grids can be used successfully in solar power stations with extremely high sunlight concentration and effective heat removal.(AIP)

BIOMASS PRODUCTION AND CONVERSION

REFER ALSO TO CITATION(S) 40497, 40500, 40501, 41175, 41724

40538 (COO—4388-3) **Acetic acid production from marine algae. Progress report No. 3, January 1, 1978—March 31, 1978.** Sanderson, J.E.; Wise, D.L. (Dynatech R/D Co., Cambridge, MA (USA)). 1 Jun 1978. Contract EG-77-C-02-4388. 35p. Dep. NTIS, PC A03/MF A01.

The program for acetic acid production from marine algae has made significant progress in the current quarter. Some of the significant developments during this period are: (1) conversion of the available reducing equivalents in Chondrus crispus to organic acids has been carried to better than 80% completion; (2) thermophilic fermentations produce higher ratios of acetic acid to total acid than is the case for mesophilic fermentations (80% vs. 50%); (3) a membrane extraction process for removing organic acid products has been developed which has potential for commercial use; (4) a large scale fermentation was shown to convert over 50% of the available carbon in five days; (5) a reducing equivalents balance on the large scale fermentation was closed to with 96% of theoretical.

40539 (NP—23690) **Retrospective search on harvesting of biomass.** (Institute for Industrial Research and Standards, Dublin (Ireland). Technical Information Div.; Western Precipitator Co., Los Angeles, CA (USA)). Nov 1977. 71p. Dep. NTIS (US Sales Only), PC A04/MF A01.

This annotated bibliography is divided as follows: harvesting of smallwood, residues, stumpwood, and thinnings; complete tree utilization; machinery for harvesting of smallwood, residues/stumpwood, and thinnings; and machinery: general. (MHR)

40540 (NP—23692) **Retrospective search on short rotation forestry.** (Institute for Industrial Research and Standards, Dublin (Ireland). Technical Information Div.; Western Precipitator Co., Los Angeles, CA (USA)). Mar 1977. 105p. Dep. NTIS (US Sales Only), PC A06/MF A01.

Centers of work on short rotation forestry are listed. This annotated bibliography covers the following: energy from wood, land availability, energy from wood residues, electricity from wood, premium wastes usage, and methods and boilers. Abstracts are included from five biomass conferences. (MHR)

40541 (NP—23693) **Retrospective search on short rotation forestry update: March 1977—February 1978.** (Institute for Industrial Research and Standards, Dublin (Ireland). Technical Information Div.; Western Precipitator Co., Los Angeles, CA (USA)). Feb 1978. 37p. Dep. NTIS (US Sales Only), PC A03/MF A01.

This annotated bibliography covers the following: additions to centers of work on short rotation forestry, energy from wood,

energy from wood residues, premium wastes usage, methods and boilers, propagation studies, and seminars. (MHR)

40542 (NP—23701) **National inventory of biomass resources: Ireland.** (Institute for Industrial Research and Standards, Dublin (Ireland). Technical Information Div.; Western Precipitator Co., Los Angeles, CA (USA)). Mar 1977. 39p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Figures are given for residues in crops, manures, and forestry wastes, municipal waste data is not included. (MHR)

40543 (SAN—0115-T2) **Mission analysis for the Federal Fuels from Biomass Program. Volume I. Summary and conclusions. Final report, December 1978.** Schooley, F.A.; Dickenson, R.L.; Kohan, S.M.; Jones, J.L. (SRI International, Menlo Park, CA (USA)). Mar 1979. Contract EY-76-C-03-0115-131. 76p. Dep. NTIS, PC A05/MF A01.

SRI International prepared this overview report on biomass derived fuels likely to achieve future market penetration and commercialization for the DOE, Solar Energy Division, Fuels From Biomass System Branch. Fifteen feedstock-to-product routes were studied in detail, and economic data were summarized for 53 missions. Using SRI's market penetration model and assuming base case feedstock availability (without federal incentives), it was determined that seven of the 53 missions studied penetrate the market in 1985, 15 missions penetrate in 2000, and 15 penetrate in 2020, producing about 0.7, 3.5, and 5.4 quadrillion Btu of useful fuel products, respectively, in each of the years.

PHOTOCHEMICAL AND THERMOCHEMICAL CONVERSION

40544 (SRO—893-16) **Development of a practical photochemical energy storage system. Quarterly report.** Hautala, R.R.; Kutal, C.R. (Georgia Univ., Athens (USA). Dept. of Chemistry). 15 Dec 1978. Contract EY-76-S-09-0893. 4p. Dep. NTIS, PC A02/MF A01.

Research was conducted on photosensitizers for the norbornadiene to quadricyclene conversion.

PHOTOVOLTAIC POWER PLANTS

40545 (COO—4094-34) **Microprocessor-controlled autonomous sun-following mount for solar photovoltaic energy planning.** Much, C.H.; Rossini, P.L.; Stuart, D.G. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 1979. Contract EY-76-C-02-4094. 6p. (CONF-790353—2). Dep. NTIS, PC A02/MF A01.

From IECI 1979 conference on industrial and control application of microprocessors; Philadelphia, PA, USA (19 Mar 1979).

A sun-following pyrheliometer mount and control system for support of a solar photovoltaic energy program has been designed. The system features the use of a microprocessor for controlling the mount and handling complex control functions required by variations in the motion of the sun. The system is a stand-alone, unattended system with capabilities for remote diagnosis by telephone.

40546 (N—79-10122) **Future orbital power systems technology requirements.** (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Sep 1978. 195p. NTIS PC A09/MF A01.

No abstract available.

40547 (N—79-10272) **Achievable flatness in a large microwave power antenna study. Final report.** (General Dynamics/Convair, San Diego, CA (USA)). 18 Aug 1978. Contract NAS9-15423. 220p. NTIS PC A10/MF A01.

Achievable flatness for the microwave power transmission system antenna array was determined. Two configurations were analyzed in detail and evaluated as to their net potential misalignment. Manufacturing, joint slack, assembly, alignment and environmental aspects were considered. Approaches to each aspect were analyzed to minimize their contributions to distortions.

40548 (SAND—79-7012) **Requirements definition and preliminary design of a photovoltaic central station test facility.** Ruzek, J.B.; Stolte, W.J. (Sandia Labs., Albuquerque, NM (USA)). Apr 1979. Contract AC04-76DP00789. 478p. Dep. NTIS, PC A21/MF A01.

Bechtel National, Inc. has conducted a study of the requirements for, and a preliminary design of, a photovoltaic central station test facility. This facility would be the first such facility dedicated to large-scale testing of photovoltaic array systems in a utility environment. The proposed initial capacity is 1 to 2 MW with capability for expansion up to 10 MW. The study included the development of the facility requirements, the facility preliminary design, design review by several electric utilities, cost estimates, preliminary environmental report and development of a site selection methodology.

SOLAR THERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 40515, 40546, 40547

CENTRAL RECEIVER

40549 (SAND—79-0697C) **Heliostat beam characterization system.** Thalhammer, E.D.; Phipps, G.S. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 37p. (CONF-790505—10). Dep. NTIS, PC A03/MF A01.

From 25. ISA international instrumentation symposium; Anaheim, CA, USA (7 May 1979).

The beam Characterization System utilizes video radiometer techniques to quantitatively describe the solar energy projected by a heliostat. This system is designed to evaluate prototype heliostats and to improve the performance of the Central Receiver Test Facility heliostats. The system consists of a beam target, video camera, analog image analyzer, calibration system, video digitizer and a minicomputer system. The calibration technique corrects for background illumination, target irregularities, vidicon shading and camera dark currents. A computer code corrects for off-axis camera angle and converts calibration and beam data into a map of screen irradiance. Post test data analysis provides the geometric centroid, energy versus radius, iso-flux contours, intensity cross sectins d 3-D intensity diagrams which are determined from the data map. The system has a fast data capture mode which can be used to study wind loading and short term tracking errors. The capabilities of the Beam Characterization System make it a useful heliostat evaluation tool.

TOTAL ENERGY AND HYBRID SYSTEMS

REFER ALSO TO CITATION(S) 41321

SOLAR RADIATION UTILIZATION

SPACE HEATING AND COOLING

REFER ALSO TO CITATION(S) 40508, 40511, 40564, 41144, 41145

40550 (BNL—25928) **Experimental performance study of a series solar heat pump.** Kush, E.A. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 6p. (CONF-790446—2). Dep. NTIS, PC A02/MF A01.

From 4. annual heat pump technology conference; Stillwater, OK, USA (9 Apr 1979).

A systematic experimental study of heat pump performance at evaporator temperatures typical of series solar input, 50 to 100°F, was conducted using a laboratory-assembled heat pump and specially constructed testing simulator. Results which show that COP's which follow the thermodynamic potential can be achieved are presented and discussed.

40551 (CONF-780337—P3, pp 6p, Book 1, Paper 3) **Modeling passive buildings using TRNSYS .** Abrash, M. (Clark Univ., Worcester, MA); Wirtshafter, R.; Sullivan, P.; Kohler, J. 1978.

From 2. national passive solar conference; Philadelphia, PA, USA (16 Mar 1978).

TRNSYS was developed for modeling active solar systems. Recently introduced transfer functions improve modeling of the building load. Modifications can be made to TRNSYS to model passive systems. Accurate treatment of direct heat gain is essential to modeling of passive systems. There are two ways to implement these improvements: (a) addition of a new subroutine to TRNSYS; and (b) use of a TYPE 15 Algebraic Routine.

40552 (COO—4704-2) **Heat pump/rock bed storage systems.** Mills, G.L.; Remmers, H.E. (Zia Associates, Inc., Boulder, CO (USA)). 1979. Contract EM-78-C-02-4704. 9p. (CONF-790328—3). Dep. NTIS, PC A02/MF A01.

From Solar energy storage options workshop; San Antonio, TX, USA (18 Mar 1979).

The characteristics of heat pump/rock bed storage components were analyzed and used to formulate TRNSYS models of potentially cost effective systems. The systems were then analyzed for performance on a typical house in Albuquerque, New Mexico and Madison, Wisconsin. Considerable emphasis was placed on system economics, since the principal goal of the project is to determine the most cost effective system. A new TRNSYS subroutine was developed to account properly for utility energy costs.

40553 (LA-UR—78-427) **Passive solar heating for buildings.** Balcomb, J.D. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 16p. (CONF-790224—1). Dep. NTIS, PC A02/MF A01.

From Workshop on passive solar design; Perth, Australia (23 Feb 1979).

A passive solar energy system is one in which the thermal energy flow is by natural means, that is by radiation, conduction, or natural convection. A survey of passive solar heating experience, especially in the U.S., is provided. Design approaches are reviewed and examples shown. Misconceptions are discussed. Advantages are listed. The Los Alamos program of performance simulation and evaluation is described and a simplified method of performance estimation is outlined.

40554 (N—79-10519) **Cost analysis of new and retrofit hot-air type solar assisted heating systems.** Stewart, R.D.; Hawkins, B.J. (National Aeronautics and Space Administration, Huntsville, AL (USA). George C. Marshall Space Flight Center). Aug 1978. 33p. NTIS PC A03/MF A01.

A detailed cost analysis/cost improvement study was performed on two Department of Energy/National Aeronautics and Space Administration operational test sites to determine actual costs and potential cost improvements of new and retrofit hot air type, solar assisted heating and hot water systems for single family sized structures. This analysis concentrated on the first cost of a system which included procurement, installation, and integration of a solar assisted heating and hot water system on a new or retrofit basis; it also provided several cost projections which can be used as inputs to payback analyses, depending upon the degree of optimism or future improvements assumed. Cost definitions were developed for five categories of cost, and preliminary estimates were developed for each. The costing methodology, approach, and results together with several candidate low cost designs are described.

40555 **Passive solar heating of buildings.** Balcomb, J.D.; Hedstrom, J.C.; McFarland, R.D. (Los Alamos Scientific Lab., NM). pp 351-369 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Passive solar heating concepts - in which the thermal energy flow is by natural means - are described according to five general classifications: direct gain, thermal-storage wall, solar greenhouses, roof ponds, and convective loops. Examples of each are discussed. Passive test rooms built at Los Alamos are described and results are presented. Mathematical simulation techniques based on thermal network analysis are given together with validation comparisons against test room data. Systems analysis results for 29 climates are presented showing that the concepts should have wide applicability for solar heating.

AGRICULTURAL AND INDUSTRIAL PROCESS HEAT

REFER ALSO TO CITATION(S) 40511, 40574

40556 (ORNL/SUB—7390/1) **Production of high-energy chemicals using solar energy heat. Project 8999, final report for the period September 1, 1977—May 31, 1978.** Dafler, J.R.; Sinnott, J.; Novil, M.; Yudow, B.D.; Rackoff, M.G. (Institute of Gas Technology, Chicago, IL (USA)). Dec 1978. Contract W-7405-ENG-26. 61p. Dep. NTIS, PC A04/MF A01.

The first phase of a study to identify candidate processes and products suitable for future exploitation using high-temperature solar energy is presented. This phase has been principally analytical, consisting of techno-economic studies, thermodynamic assessments of chemical reactions and processes, and the determination of market potentials for major chemical commodities that use significant amounts of fossil resources today. The objective was to identify energy-intensive processes that would be suitable for the production of chemicals and fuels using solar energy process heat. Of particular importance was the comparison of relative costs and energy requirements for the selected solar product versus costs for the product derived from conventional processing. The assessment methodology used a systems analytical approach to identify processes and products having the greatest potential for solar energy-thermal processing. This approach was used to establish the basis for work to be carried out in subsequent phases of development. It has been the intent of the program to divide the analysis and process identification into the following three distinct areas: (1) process selection, (2) process evaluation, and (3) ranking of processes. Four conventional processes were selected for assessment namely, methanol synthesis, styrene monomer production, vinyl chloride monomer production, and terephthalic acid production.

40557 (PB—287286) **Assessment of a semi-closed, renewable resource-based aquaculture system, six-month progress report.** Todd, J.; Zweig, R. (New Alchemy Inst., Woods Hole, MA (USA)). 23 May 1978. 94p. NTIS PC A05/MF A01.

This report combines theoretical studies on the nature of solar-driven, semi-closed aquatic ecosystems and their practical application for the culture of fishes. Solar and bio-technologies developed for raising fish cheaply, productively and on predominantly indigenous and low-quality feeds are being evaluated. Underlying the above is a research program to elucidate and model the biological enrichment process within the test facilities and their susceptibility to variations in solar and thermal conditions. The responses of the aquaculture facilities to high population densities, heavy feeding, the build-up of indigenous toxic metabolites and natural oscillations in light and thermal conditions are being monitored and modeled to determine the factors which limit solar-based aquaculture. (Color illustrations reproduced in black and white)

40558 **Drying beef-packing-plant wastes by direct application of solar energy.** Brusewitz, G.H.; Farmer, D.M. (Oklahoma State Univ., Stillwater). pp 515-519 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Energy for processing nearly all food items is nearly twice the energy content of the food product. Water is used in large volumes by almost every food-processing plant, and there is nearly always a problem disposing of low-quality water. What is needed is a means of separating the solid fraction from the liquid since each component has economic value. Removal of moisture by evaporation requires high energy. The food raw material itself can be the collecting surface in harvesting the sun's energy, and this energy can be used to dry high-moisture food materials. A solar dryer is suggested for those drying operations that do not have hourly demands. Rather, those drying operations, such as handling wastes, which allow some flexibility in their need for energy would be very advantageously adaptable to using the solar dryer. Beef-packing-plant paunch, a waste product in the past, is an example of a high-moisture low-value food-processing-plant material. Beef-processing plants, which are energy-intensive, are important nationally in total and in numerous locales. The potential energy savings to just this one part of the meat-packing industry is estimated at 3.3 trillion Btu's annually.

40559 **Direct solar drying of fruits and vegetables in the Southeastern United States.** Bryan, W.L. (US Citrus & Subtropical Products Lab., Winter Haven, FL). pp 521-525 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Increasing cost and lowered availability and dependability of fossil fuels are encouraging use of solar energy for food drying. Weather conditions in the Southeastern US do not permit traditional open-air sun drying, which is the most direct and efficient method of transferring solar energy to evaporation of water during drying. This paper describes a 24-hour-batch solar-drying process for fruits and vegetables, using an enclosed solar-collector/hot-air dryer with transparent covers and with flat reflectors mounted to increase solar radiation to the food tray. In this process, drying is completed overnight during the falling-rate drying period using low flow of air heated from fossil fuels or stored solar energy. The process has been demonstrated in preliminary drying tests with diced carrots using different conditions of direct and/or reflected solar radiation.

40560 **Compatibility of solar energy supply, collection and storage with food processing energy demands.** Lund, D.; Buelow, F.; Duffie, J. (Univ. of Wisconsin, Madison). pp 527-528 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Process streams that were identified as likely opportunities for significant contributions from solar energy in food-processing energy demands are meat processing (pig dehairing, scalding, clean-up, boiler feed water heating); dairy processing (pasteurization, washers, clean-up, boiler feed water heating); vegetable processing (blanchers, topping water, flume, cleaners, and boiler feed water heating). The objective of this study was to establish energy demands in terms of flow rates and temperatures of hot water and steam for these processes; to incorporate models for energy demands in the model for solar energy supply and collection to determine compatibility of using solar energy in food-processing systems; and to analyze economic feasibility of using solar energy in these processes. Once the demand models have been generated, the solar energy supply model will be utilized to determine the size of the solar-assist unit and the economic feasibility. It was found that it was necessary to use hour-by-hour data in the solar-supply model. The solar collection and storage system was modeled and shown in a diagram specifically for the retrofit of vegetable-canning operation with solar energy supply. (MCW)

40561 **Testing some concepts of freeze drying and osmovac drying with solar energy.** Moy, J.H. (Univ. of Hawaii, Honolulu). pp 529-

530 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Almost all of the solar drying of food and agricultural products thus far is by direct and indirect drying. Direct exposure of materials to the sun for drying is simple and convenient, but may have quality and sanitation problems. Indirect drying utilizes solar-heated air or water which is then conductively or convectively transferred to the material. Both of these can be categorized as air drying with solar energy. Since feeeze drying provides good product quality but is known to be expensive, attempts have been made to make it more economical by improving its drying rate/or reducing the energy cost. Conceivably, freeze drying can be carried out in vacuo or in a nonvacuum system utilizing solar energy as a major source of energy for sublimation. Osmovac drying of piece-form foods can also incorporate solar energy for increasing the osmotic drying rate, for vacuum drying, and also for concentrating the syrup. Experiments are being designed to test these concepts and to understand the problems involved.

40562 Solar-process drying of potato products. Smith, C.C. (Colorado State Univ., Fort Collins). pp 531-535 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

A project at Colorado State University is directed at the development and demonstration of solar systems to dehydrate potato products. Flat-plate air-heating solar collectors are employed that supply the heated air to conventional-process dehydration equipment. The supply of solar-heated air to spray or cyclone dryers, for the drying of potato starch, and to foam-mat belt dryers, for cut-up potato forms, was studied. Drum-type dryers were not considered because steam is required by such equipment beyond the temperature capability of the flat-plate solar collector. One solar collector design utilizes high-absorptivity coating on an absorber plate over which two glass panes are provided to resist heat loss to the environment. A second design utilized a selective absorber coating with high solar absorptivity but low longwave emittance and with a single fiberglass cover. An illustration is shown of the flat-plate solar collector supplying heat to a process belt dryer which is drying potatoes. The collectors supply air at temperatures up to 150°F to the final stage dryer. The air which is exhausted from this dryer is relatively dry and at temperatures normally above ambient air which enters the collectors. This process is being demonstrated with a 100-square foot small-scale solar dryer.

WATER HEATING

REFER ALSO TO CITATION(S) 40572, 41118, 41144

40563 Developments in domestic solar-hot-water heating. Wolf, D.; Tamir, A.; Kudish, A.; White, D.H. (Ben Gurion Univ., Beer Sheva, Israel). pp 335-349 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Domestic water heating by solar energy is very common in Israel and its use is increasing steadily. Solar-water-heating units are commercially available and can be seen on roofs all over the country. Due to aesthetic as well as economic reasons, central solar water heating for whole apartment buildings has been promoted and many demonstration units have been built and successfully operated. It is expected that, in the near future, all apartment buildings will be equipped with central solar heaters, especially hotels, hospitals, institutions, and the like. The central solar-heating units operate with forced and controlled circulation, while the single dwelling units are of the thermosiphon type. The adaptation of a pump and thermostat to single units, which enables removal of the storage tank from the roof in order to improve on the aesthetic aspects is being considered. Domestic water heaters are also common in other places in the world such as Australia, Japan and the USA, but the economics are not always satisfied and it is not truly a common commercial item. The development of the solar hot water heating, the incentives, impediments, and future potentials are described, and, except for corrosion problems, involves a harmless substance. Domestic hot water management should involve more consideration to (a) hot water circulation systems for heating in winter and (b) the use of hot or chilled water for cooling in the summer. Thus, the key problems of management become the interrelations between the trade-offs of various systems involving such uses, e.g., water storage and integration into electrical power systems to assist in reducing peak electrical power loads, rather than adding to peak loads.

40564 Solar space and domestic water heating in Central Europe. Birnbreier, H.; Ziegenbein, B. (Brown, Boveri and Cie AG, Heidelberg, Germany). pp 371-376 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The most-promising solar applications for Central Europe are swimming-pool heating, domestic water heating, and space heating. There is no need for air conditioning during the summer; the amount of diffuse radiation is too high for thermal conversion into electricity. A large demonstration plant for solar heating of a public swimming pool has been built in Wiehl near Cologne, West Germany. Mostly in West Germany, the hot-water-heating system is coupled directly to the oil boiler for space heating. This specific situation offers a favorable opportunity to introduce a domestic water-heating system that utilizes solar energy together with auxiliary electrical heating for bad-weather periods. Characteristics of the commercial systems available in Europe are described; specifically, the characteristics of the BBC-Solarwatt-System for domestic hot water are given. Approximately 50% of the annual load for space heating in one-family residences in Europe is required from mid-November to mid-February. Up to 20% of the annual load can be met by solar energy using normal single or double-glass collectors. One possibility of increasing the solar contribution is to use vacuum collectors that reduce the heat losses of the absorber. A solar-space-heating system of this type with an electrically driven heat pump was installed in the BBC-Solar House near Heidelberg. Different solar-space-heating systems are commercially available in Europe; but in contrast to the domestic hot-water systems, they are still not economically feasible. (MCW)

SOLAR COLLECTORS AND CONCENTRATORS

REFER ALSO TO CITATION(S) 40509

40565 (ALO—5319-1) **Isothermal flow distribution in solar collectors and collector manifolds.** Jones, G.F.; Lior, N. (Pennsylvania Univ., Philadelphia (USA). Dept. of Mechanical Engineering and Applied Mechanics). 1978. Contract EM-78-C-04-5319. 5p. (CONF-780808—27). Dep. NTIS, PC A02/MF A01.

From Meeting of the American Section of the International Solar Energy Society; Denver, CO, USA (28 Aug 1978).

As a first step to a detailed analysis of the influence of flow in solar collector absorber tubes on the collector's heat transfer and thermal performance, this study investigates the distribution of isothermal flow through a typical system consisting of two manifolds connected by a number of parallel riser-tubes. No thermal effects are taken into account. A discreet hydrodynamic model was developed for this system, and the resulting set of simultaneous nonlinear algebraic equations was solved numerically by the successive substitution method, for 23 different combinations of the major independent variables. Quantitative flow distribution results are presented. In the investigated range, it was determined that the two parameters which have the major influence on flow distribution are the ratio of riser diameter to manifold diameter, and the number of risers, with maldistribution increasing with both of them.

40566 Device for the collection, storage and use of solar energy. Coles, E.F. (to Barry-Wehmiller Co., Saint Louis, MO (USA); Deutsches Patentamt, Muenchen (Germany, F.R.)). German(FRG) Patent 2,746,829/A/. 20 Apr 1978. 17p. (In German).

The invention describes a solar collector system with connected latent heat storage and flow material circulating system. The collector and store are situated in a common framework, but the store is protected by thermal insulation from direct contact with the external air. The heat store has internal flow channels, which are connected into the circulation system, and also has closed chambers used for heat exchange. The heat exchanger can either be supplied with heat from the collector or from the phase changing material in the store by the circulation system. A control circuit controls the heat supply of the heat exchanger.

40567 (N—79-10522) **Development of surfaces optically suitable for flat solar panels. Final report.** Desmet, D.; Jason, A. (Alabama Univ., University (USA). Dept. of Physics and Astronomy). 1978. Contract NAS8-32481. 46p. NTIS PC A03/MF A01.

Three areas of research in the development of flat solar panels are described. (1) A reflectometer which can separately evaluate the spectral and diffuse reflectivities of surfaces was developed. The reflectometer has a phase locked detection system. (2) A coating composed of strongly bound copper oxide that is formed by an etching process performed on an aluminum alloy with high copper content was also developed. Because of this one step fabrication process, fabrication costs are expected to be small. (3) A literature search was conducted and conclusions on the required optical properties of flat plate solar collectors are presented.

40568 (PNL—2969) **Effects of noncontact cleaners on transparent solar materials.** Hampton, H.L.; Lind, M.A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1979. Contract EY-76-C-06-1830. 72p. Dep. NTIS, PC A04/MF A01.

A brief study has been undertaken to evaluate the performance of noncontact cleaning agents for use on solar collectors. Several techniques are used to compare cleansing agents which have been recommended by their respective manufacturers for cleaning solar mirrors. Wetting and residue buildup properties are evaluated for over 50 of these commercially available cleaners. The wetting properties of each cleaner are evaluated by measuring the growth of the contact area of a constant volume drop as a function of time. Losses due to residue buildup are solar weighted and considered equally with the wetting parameters and cost figures to construct a figure of merit for cleaner comparison.

40569 (SAND—79-0215C) **Structural optimization of sheet molding compound line focusing collectors.** Reuter, R.C. Jr.; Allred, R.E. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 6p. (CONF-790517—1). Dep. NTIS, PC A02/MF A01.

From 24. annual SAMPE symposium; San Francisco, CA, USA (8 May 1979).

One of the primary structural components of a line focusing solar collector is the reflector support. In this design, it must be a stiff, light weight, parabolic trough which provides and maintains the correct optical shape for the reflective surface, and protects it from detrimental environmental effects. A viable candidate for the reflector support is a moldable, fiber reinforced, rib stiffened structure which has a low cost, high production rate potential. This paper covers material and analytical considerations made to insure that the sheet molding compound panel design meets specified structural requirements. A detailed analysis is provided and optimization is achieved through steps taken to minimize panel weight.

40570 **Apparatus for concentrating solar energy.** Hein, L.A.; Myers, W.N. US Patent 4,139,286. 13 Feb 1979. Filed date 30 Jan 1976. 8p.

The invention relates to apparatus for collecting solar radiation rays and for converting the radiaion rays into a concentrated beam of parallel rays having a fixed orientation. The apparatus includes an optical system for collecting and concentrating the solar radiation rays and for converting the rays into concentrated beam of parallel rays. A system of mirrors is utilized to provide a concentrated beam of parallel rays which remain fixed in orientation as the optical system is rotated around a tracking axis. The concentrated beam of fixed orientation is then utilized for supplying thermal energy to a stationary solar appliance.

40571 **Solar energy absorber.** Jones, J.P. Jr. US Patent 4,131,110. 26 Dec 1978. Filed date 6 Jan 1977. 6p.

A group of elongated, thin wall, black, PVC tube-like tanks are disclosed extending horizontally and parallel to one another in an array. The tank ends are connected to fluid inlet and outlet manifolds. Rapid assembly of tanks and manifolds is facilitated by loose joints between tanks and tapered apertures in manifolds receiving tubular inlets and outlets on tanks. Also, the tubular/taper design makes an interference fit and sets up ideal conditions for liquid welding. Each tank has built in protection in the form of retained fluid in the event of failure of the pumping system.

40572 **Solar liquid/air heater.** Hillman, E.K. US Patent 4,112,920. 12 Sep 1978. Filed date 16 Aug 1976. 8p.

Apparatus is disclosed for utilizing the energy of the sun to heat a rotatable round metal tank. The tank is cradled upon two sets of wheels, of which one set of sheels is powered by an electric motor. The tank is placed in horizontal position upon the two sets of wheels which are near ground level. The round metal tank is constructed with a divider/separator to form two separate compartments to hold or contain liquid and/or air. On the horizontal extremities of the round metal tank are outlet openings and inlet openings for the passage of liquid/air to move through the separate compartments. Adjacent and flanking the round metal tank are deflectors to concentrate solar energy toward the round rotatable metal tank. Arcing over the round metal tank is a transparent cover to aid in the heat retention during and after the round tank is heated by solar energy. The inlet openings and outlet openings are placed close to the divider/separator and also close to the peripheral area of the metal tank. The rotational movement of the round metal tank is powered by a small motor that turns one set of wheels in the direction that causes the separate compartment tank to tilt and this action causes the liquid to flow out of the compartment by the use of gravity into a container, this liquid then to be used by the user at his discretion by operating a pump.

40573 **Solar collector system.** Kofink, S. (to Eberspaecher (J.), Esslingen (Germany, F.R.); Deutsches Patentamt, Muenchen (Germany, F.R.)). German(FRG) Patent 2,631,771/A/. 19 Jan 1978. 13p. (In German).

The invention concerns a solar collector. The absorber of the system is formed by metal plates - preferably of aluminium. One plate is selectively coated, the second plate has a black coating. The heat transfer medium - preferably water or a mixture of ethyleneglycol with water - flows between both plates. The sun-turned covering of the absorber is made of plexiglass. The absorber is thermally insulated on its back.

HEAT STORAGE

40574 (DOE/NASA/1034—79/2) **Thermal storage technologies for solar industrial process heat applications.** Gordon, L.H. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1979. Contract EC-77-A-31-1034. 20p. (NASA-TM—79130; CONF-790328—5). Dep. NTIS, PC A02/MF A01.

From Solar energy storage options workshop; San Antonio, TX, USA (18 Mar 1979).

Industrial production uses about 40% of the total energy consumed in the United States of which the major share is derived from fossil fuel. Significant savings of scarce fossil fuel is possible through the use of thermal energy storage and/or solar generated process heat. The state-of-the-art of thermal storage subsystems for the intermediate and high temperature (100°C to 600°C) solar industrial process heat generation is presented. Primary emphasis is focused on buffering and diurnal storage as well as total energy transport. In addition, advanced thermal storage concepts which appear promising for future solar industrial process heat applications are discussed.

40575 **Solar heating (cooling).** Thomason, H.E.; Thomason, H.J.L. Jr. US Patent 4 139,055. 13 Feb 1979. Filed date 17 Jun 1976. 4p.

In the present invention, a plurality of containers provide for heat storage in water or other fluids, or solids, or both, plus domestic water heating. There is good quality heat exchange going in to storage and going out to points of use. Space heating may be accomplished by hot air, or by hot water or other liquid, or both.

GEOTHERMAL ENERGY

40576 **Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1.** Davis, California; Geothermal Resources Council (1978). 385p. (CONF-780708—P1).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

One hundred and one papers are included. Nine papers were previously abstracted for EDB. Separate abstracts were prepared for the remaining papers.

40577 **Multi-purpose geothermal test and experimental activities at Raft River, Idaho.** Chappell, R.N. (Department of Energy, Idaho Falls, ID); Griffith, J.L.; Knowles, W.R.; Schultz, R.J. pp 83-85 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The largest variety of geothermal tests and experimental activities at any single location in the world are underway or developing at a remote geothermal test site in south-central Idaho. The majority of the DOE sponsored research conducted by scientists from the Idaho National Engineering Laboratory (principally EG and G Idaho employees) is devoted to investigating many uses of moderate temperature hydrothermal resources. The work also includes a significant environmental baseline and long-term effects program; resource discovery, production, control and disposal; fluid handling techniques from downhole pump to the miles of buried surface lines moving fluids between the production wells and the experimental facilities.

40578 **Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2.** Davis, CA; Geothermal Resources Council (1978). 756p. (CONF-780708—P2).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Ninety-nine papers are included. Ten papers were previously abstracted for EDB. Separate abstracts were prepared for the remaining papers. (MHR)

RESOURCE STATUS AND ASSESSMENT

REFER ALSO TO CITATION(S) 41116

USA

40579 Learning curve concept applied to the development of a hydrothermal resource. Barkman, J.H. (Republic Geothermal, Inc., Santa Fe Springs, CA). pp 31-33 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The geothermal industry has been slow in developing hydrothermal resources for a variety of reasons. These include institutional barriers, marginal economics and technical uncertainties. Conservative investors and utilities have been reluctant to proceed until perceived problems are resolved and solutions are demonstrated. It is argued that the industry is in fact on a learning curve and that significant advances in knowledge, technology and economics will be made as projects move forward. The learning curve concept is illustrated with actual examples taken from Republic's early development experience in the East Mesa field and its related engineering design of a flashed steam power plant.

40580 Planning for geothermal development in Hawaii. Chen, B.H.; Grabbe, E.M. (Hawaii State Dept. of Planning and Economic Development, Honolulu, Hawaii). pp 95-97 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

In 1976 the University of Hawaii completed a successful exploratory geothermal well on the Big Island of Hawaii. The well has raised hopes for a viable alternate energy source to reduce the State's high dependence on imported petroleum. A Development Group was organized to install a wellhead generator to demonstrate the feasibility of utilizing geothermal energy from a volcanically active area. The State is also planning for geothermal development through scenario development, identification of constraints and barriers, resource assessment and non-electric applications.

40581 Feasibility of potential geothermal energy applications for Riverside, California. Fassbender, L.L. (Battelle Pacific Northwest Labs., Richland, WA); Bloomster, C.H.; Schilling, A.H. pp 189-192 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Geothermal energy has a promising potential to supply electricity, space heating and cooling, and process heat to Riverside. There are sufficient geothermal resources within 200 miles to supply the electrical requirements of Riverside for thousands of years at costs ranging from 1 to 3 times the cost of conventional electric power generation. The geothermal resource at nearby Arrowhead Hot Springs has the potential to supply space heating and cooling and process heat to Riverside for a hundred years at 1 to 2 times the cost of conventional fuels, depending on the population density of the service area. The most difficult problems in the possible use of geothermal energy in Riverside appear to be institutional difficulties in electric applications.

40582 State maps of low-temperature geothermal resources. Grim, P.J. (National Oceanic and Atmospheric Administration, Boulder, CO); Nichols, C.R.; Wright, P.M.; Berry, G.W.; Swanson, J. pp 233-234 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A series of geothermal energy resources maps for about 12 western states are being prepared by the National Geophysical and Solar-Terrestrial Data Center (NGSDC) for the Department of Energy. These maps will emphasize the occurrence of relatively low-temperature thermal resources that can be used in direct, nonelectric heat applications. The purpose in producing these maps is to promote the use of geothermal energy in the United States as an alternate energy resource. It is hoped that the maps will make potential users of this energy resource aware of its availability and will show them areas that are likely to yield such resources. Tentatively, two maps for each state are planned: a "planning" map and a "scientific" map. The states participating include: Alaska, Hawaii, Washington, Oregon, California, Idaho, Montana, Nevada, Colorado, Utah, Arizona, and New Mexico.

40583 Evaluation of wildcat geothermal prospects on federal lands. Isherwood, W.F.; Mac Gillvray, T.J. (Geological Survey, Menlo Park, CA). pp 313-315 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A quantitative "best guess" as to the economic value and risk of geothermal prospects prior to definitive deep drilling is often required. There are probably as many different methods of evaluation currently being used as there are groups working on such evaluations. The methodology used by the U.S. Geological Survey is described briefly as a springboard for discussion of these methods by the professional community, and to allow those not presently involved to realize the complexities and uncertainties.

40584 Utility estimates of geothermal electricity generating capacity. Kruger, P.; Roberts, V. (Electric Power Research Inst., Palo Alto, CA). pp 379-382 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Estimates of geothermal electric power generation capacity by the electric utility industry, obtained from both formal forecasts through the National Electric Reliability Council (NERC) and an informal survey conducted by EPRI in 1978, indicate a significant growth in reliance on geothermal resources compared to the estimates obtained a year ago. Data from the 10-year coordinated plan summaries of the Western Systems Coordinating Council for 1976 and 1977 show a 15%/a growth rate in geothermal power capacity over the 10-year periods; and in relation to the forecasted decline in total additions, it represents an increase of 20% in reliance on geothermal resources. The informal survey of more than 15 utilities showed a probable growth of geothermal power capacity of 7,475 MWe by 1995, at a mean growth rate of 16%/a. In comparison to the survey of 1977, the increase in announced capacity is more than 100%.

40585 Volcanism and the regional assessment of geothermal potential in west-central Utah. Nash, W.P.; Turley, C.; Petersen, J.; Brown, F.H. (Univ. of Utah, Salt Lake City). pp 475-477 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The geologic setting, lithology, age relationships, chemistry, and regional exploration criteria of west-central Utah are discussed. (MHR)

40586 Status report: geothermal operations research project for California and Hawaii. Wiegand, J.W.; Cummings, C. pp 717-719 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The project objective is to develop realistic scenarios for the development and commercial utilization of geothermal energy resources in Heber, California, and Puna, Hawaii. Preliminary recommendations resulting from the analyses of the Heber scenario are shown. (MHR)

40587 Utilization of hot dry rock: a scenario. Williams, R.E. (Denver Research Inst., CO). pp 725-727 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A scenario is presented for a hypothetical town in the Rocky Mountains located in a potential KGRA which instituted a plan in 1977 to make them energy independent by the turn of the century. The geothermal criteria, the results of geological and geophysical studies, and exploratory drilling are listed. Steps in the geothermal development are mentioned. (MHR)

NON-USA

REFER ALSO TO CITATION(S) 40611

40588 Thermal waters of Bulgaria: present use and probable origin. McEuen, R.B. (Woodward-Clyde Consultants, San Francisco, CA). pp 423-426 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Bulgaria is a country that is presently undergoing crustal shortening. It is also a country that has many geothermal manifestations. To date, most geothermal studies have dealt with areas undergoing crustal extension. Moderate temperature resources may be expected in compressional areas that, like Bulgaria, have virtually no indication of recent igneous activity. For such areas, the most likely heat source is recently faulted radiogenic rocks similar to the granite so prevalent in the Balkan and Rila Mountains of Bulgaria. As compressional areas tend also to be areas of mountain building, their moderate temperature resources find ready application in space heating. In Bulgaria, present usage is primarily balneological and horticultural; however, direct heat is used to process linen, and antibiotics are being produced from algae grown in carefully monitored ponds filled with geothermal fluid. As in other geothermal regimes, in Bulgaria there is a direct correlation between regional seismicity and geothermal resources potential. Trace element analysis of groundwater has been highly developed in Bulgaria as an exploration aid in the search for subterranean mineralized thermal waters.

GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS

REFER ALSO TO CITATION(S) 40739, 40767

40589 (LBL—9001) **Analytic study of geothermal reservoir pressure response to cold water reinjection.** Tsang, Y.W.; Tsang, C.F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1978. Contract W-7405-ENG-48. 14p. (CONF-781222—4). Dep. NTIS, PC A02/MF A01.

From 4. workshop on geothermal reservoir engineering; Stanford, CA, USA (13 Dec 1978).

Derivation of the governing equation, including temperature effects, is given where the permeability-viscosity ratio is assumed to be an arbitrary function of r^2/t. This function is represented by a Fermi-Dirac function, whose parameters are determined based upon physical considerations. The solution for the pressure change is analytic except for the final step, where a numerical integration is called for. The results and implications of the calculations are discussed. Summary and concluding remarks are presented.

40590 **Temperatures and their dependence on groundwater flow in shallow geothermal systems.** Chapman, D.S.; Kilty, K.T.; Mase, C.W. (Univ. of Utah, Salt Lake City). pp 79-82 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A conceptual model of a shallow geothermal system is characterized by groundwater percolating into a storage area, being heated and then discharging to the surface through a permeable conduit. The analysis of this system involves finite difference solutions to the equation of conductive and convective heat transfer with appropriate boundary conditions. The model is successfully applied at Monroe Hot Springs, Utah, where dipole—dipole resistivity, and ground magnetics surveys have effectively mapped the system and where eleven thermal gradient/heat flow boreholes provide temperature-depth constraints. The subsurface temperature field is shown to be controlled by groundwater discharge through the Sevier fault zone.

40591 **Steam/water relative permeabilities from production data.** Horne, R.N.; Ramey, H.J. Jr. (Stanford Univ., CA). pp 291-293 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

It was suggested by Grant (1977), that the steam/water relative permeability of the producing geothermal reservoir could be inferred from the production history of the Wairakei field. As production has occurred, most wells have shown enthalpy rises. Considering the enthalpy and discharge histories he obtained a curve of steam permeability against water saturation that was significantly different from the classical curve from Wyckoff and Botsett (1957, p. 161) for two immiscible fluids (one gas and the other liquid). However, Grant made a number of approximations, and together with the natural scatter of the field data the end result was a "regional" curve rather than a single line curve. It has been possible to achieve considerable improvement on these preliminary results, and a more precise pair of relative permeability curves has been obtained. It now seems possible to extend this analysis further to determine the relative permeabilities from well data without requiring a very long history of production. Furthermore, the behavior of two-phase flow in a fracture (for example, as in the Hot Dry Rock configuration) may be evaluated.

40592 **Reservoir engineering aspects of fluid recharge and heat transfer in geothermal reservoirs.** Miller, F.G.; Cinco, H.; Ramey, H.J. Jr.; Kucuk, F. (Stanford Univ., CA). pp 449-452 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Natural recharge of fluid filled geothermal reservoirs is shown to be important in the development of these reservoirs and in increasing geothermal energy reserves. Research contributions on methods for calculating water influx and heat transfer in petroleum reservoirs are discussed. The need to forecast the performance of geothermal fluid reservoirs subject to water influx is emphasized.

40593 **Helium in fumarole and well gases as an index of long-term geothermal potential.** Naughton, J.J.; Thomas, D. (Univ. of Hawaii, Honolulu). pp 479-481 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Fumaroles and degassing vents around Kilauea volcano were used as models of producing geothermal areas. Excess helium has been found in gases from fumaroles characterized by long-term activity, and is absent in gases from short-lived hot spots, from dry vents or fissures formed by recent activity, and from old degassed lava lakes. From this it is inferred that the absence of helium in gases from geothermal areas would indicate that they receive heat from a limited magma body, and would be expected to yield extractable heat for only a comparatively short period. The geothermal well at Puna, Hawaii, has given positive helium indications.

40594 **Algebraic technological function: a mechanism for integrating physical and economic factors in groundwater management.** Maddock, T. III. (Univ. of Texas, Austin). pp 562-563 of 1974 joint automatic control conference. Proceedings. New York, NY; American Institute of Chemical Engineers (1974).

From 15. joint automatic control conference; Austin, TX, USA (18 Jun 1974).

Simulation models and economic models may be combined together in management models through the use of an algebraic technological function (ATF). The use of ATF is reviewed. These functions aid in managing the conjunctive use of surface and ground waters when interaction can occur between systems management for water quality management by relating pollutant concentrations to water withdrawal or injection, and for geothermal management by relating pressure and temperature to water withdrawals. (MHR)

USA

REFER ALSO TO CITATION(S) 40652

40595 **Geological and hydro-geochemical study of the La Grande area, Union County, Oregon.** Dellechaie, F. (AMAX Exploration, Inc., Denver, CO). pp 145-148 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Several thermal springs and wells are in the Grande Ronde Valley of northeastern Oregon. The valley is a complexly faulted graben. The hottest waters are closely associated with faults and fault intersections. The youngest rocks in the area are Miocene andesites. Thermal waters contain approximately 500 mg/l of dissolved solids. The hottest waters contain sodium and chloride as principal ions while sodium and bicarbonate predominate in cooler waters. All thermal waters appear to have equilibrated below 100°C and generally within 25°C of their surface temperature. Waters show no evidence of mixing. Data thus far indicate that the La Grande area is not suitable for geothermal electric production. The area holds great promise however, for low temperature usage based on the availability of hot water and current industrial demand for the resource.

40596 **Geologic characteristics of the Valles Caldera geothermal system, New Mexico.** Dondanville, R.F. (Union Oil Co. of California, Santa Rosa). pp 157-160 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The geology, geophysics, and deep drilling results in the Valles Caldera are reviewed. (MHR)

40597 Mineral assemblages of hydrothermal alterations of basalts from Hawaii. Fan, P.F. (Univ. of Hawaii, Honolulu). pp 185-187 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Hydrothermal minerals of Hawaii can be grouped into five zones; (1) actinolite (~ >340°C), (2) chlorite (~ 325 to 340°C), (3) montmorillonite (<325°C), (4) kaolinite, and (5) alunite. Actinolite, chlorite, and montmorillonite zones are present in Hawaiian geothermal project well-A, Kilauea Volcano, Hawaii. A chlorite zone is also found in Koolau Caldera, Oahu. Kaolinite and alunite zones are present in southwestern Moloka‡. The zonal distribution of hydrothermal minerals is related to temperature, permeability, and composition of the hot fluid, and resulted from the vertical or lateral migration of the hot fluid to the surrounding basalts.

40598 Relationship of a geothermal reservoir to the geological structure of the east rift of Kilauea Volcano, Hawaii. Furumoto, A.S. (Univ. of Hawaii, Honolulu). pp 199-201 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A knowledge of the geological structure of the east rift of Kilauea Volcano, Hawaii, greatly helped in understanding the hydrothermal process of a geothermal reservoir found there. The source of energy was a hot, broad dike complex at a depth of 2.3 km. The geothermal reservoir is located in a rock layer with fractures caused by tensional stresses. The reservoir was capped by a self sealing process due to filling of fractures by secondary minerals.

40599 Natural flow-fluid patterns in the Salton Sea Geothermal Field. Kasameyer, P.W. (Univ. of California, Livermore); Younker, L.W. pp 359-361 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The direction and magnitude of the horizontal flow at the Salton Sea Geothermal Field (SSGF) are discussed. Evidence has been published indicating that the natural flow in the field is from the southeast to the northwest. It is suggested that a model of large-scale convection about an intrusion explains many aspects of the natural temperature distribution. In this model the direction of natural flow is exactly opposite to that predicted from regional hydrology. This model is by no means unique, nor is the proof of the direction of flow definitive. The model is discussed in order to indicate the uncertainty in the direction of preproduction flow. This model can be tested with numerical simulators. The results of those simulations could suggest additional measurements or analysis which would determine the true direction of flow.

40600 Pagosa Springs project: the first permitted geothermal wells in Colorado. Pearl, R.H.; Galloway, M.J.; Dick, J.D. (Colorado Geological Survey, Denver). pp 517-519 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The geothermal resources at two areas in Colorado - Pagosa Springs and Glenwood Springs - are being explored and developed for direct application uses. At the first site, Pagosa Springs, any thermal waters developed will primarily be used to heat a new high school complex. Geological, hydrogeological, geophysical, and geothermometer studies were done in the region to fully delineate the reservoir. It was determined that the reservoir encompasses some 4 sq. kilometers and may have a temperature of 125°C. Before drilling commences it was necessary to apply for permits from the Colorado Oil and Gas Conservation Commission, Water Quality Control Commission, and Air Quality Control Commission. All permits have been issued. To test the aquifer and to determine what legal hydrological conditions the thermal waters are occurring under, a 2 to 3 day aquifer test will be run.

40601 Natural concentrations of Hg in the Yellowstone and Coso geothermal fields. Phelps, D.W.; Buseck, P.R. (Arizona State Univ., Tempe). pp 521-522 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The association of Hg mineralization with geothermal activity is well-documented. More recently, anomalous amounts of Hg have been discovered in geothermal areas that have no associated Hg mineralization. New data from Yellowstone National Park and Coso Hot Springs, Inyo County, California, showing anomalous concentrations of Hg in soils, rocks and hot spring deposits from these thermal regions are discussed.

40602 San Diego Gas and Electric Company's Geothermal Program. Swanson, C.R. (San Diego Gas and Electric Co., CA). pp 639-642 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The technical, environmental, and economic risks in geothermal development are listed. SDG and E's current geothermal program is outlined. The work at Niland Geothermal Loop Experimental Facility and Magma Power's pilot plant at East Mesa is reviewed. (MHR)

40603 Modeling the Heber Geothermal Reservoir. Tansev, E.O. (Chevron Resources Co., San Francisco, CA); Wasserman, M.L. pp 645-648 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The lithology, temperature, and pressure of the Heber Geothermal Reservoir is described briefly. This is based on the extensive data gathered in the past few years through well drilling and testing. Then the three-dimensional, heterogenous, single phase water flow simulator is described including the equations solved, and the assumptions made. Several applications of the numerical simulator are presented in predicting the reservoir behavior with time. Conclusions based on an analysis of simulator results are finally presented.

40604 Streaming potentials resulting from the descent of meteoric water: a possible source mechanism for Kilauean self-potential anomalies. Zablocki, C.J. (Geological Survey, Denver, CO). pp 747-748 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Electrofiltration (streaming) potentials can arise when a differential fluid pressure exists in the pore-water system of a rock. The proposed mechanism involves the assumption that the surface potential intensities are directly proportional to the thickness of the vadose zone.

NON-USA

40605 (N—79-10501) **Remote sensing applied to prospecting of thermomineral water in the County of Caldas Novas-Goias.** Veneziani, P.; Eustaquiodosanjos, C. (National Aeronautics and Space Administration, Washington, DC (USA)). Nov 1978. Translated from Sensores Remotos Aplicados a Prospeccao de Aguas Termominerais No Municipio de Caldas Novas-Goias, Aug 1978, 10p. 13p. NTIS PC A02/MF A01.

LANDSAT imagery of the region were studied allowing the placement of the area of study in the regional geological context. A geological mapping of the 1.60.000 scale was done. A methodology was developed which consisted in a regional temperature mapping using trend surface analysis. Through the correlation of all these data, four different areas were localized with a high potential as thermomineral sources.

40606 Hydrothermal mineralogy and isotopic geochemistry in the Cerro Prieto geothermal field. III. Practical applications. Elders, W.A.; Hoagland, J.R.; Olson, E.R. (Univ. of California, Riverside). pp 177-180 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

These studies of rock samples from geothermal boreholes use a combination of mineralogy, light stable isotopes, fluid inclusions and other methods of geothermometry. This approach has proved cost effective and rapid when applied to practical problems of exploration at Cerro Prieto. It was possible to predict temperatures and make qualitative statements about permeability during drilling. The predictions were largely substantiated when the boreholes were subsequently tested. This kind of timely information helps determine final depth and the siting of future wells. One can also identify zones of different permeability, and distinguish between the natural recharge, discharge, and heating regimes of the geothermal system. Thus the effective hydrology and its evolution in the natural state can be described. Although these concepts were developed as a result of studies in the Salton Trough, it is believed that, with suitable modifications, they can be applied to various different types of geothermal fields elsewhere.

40607 Hydrothermal mineralogy and isotopic geochemistry in the Cerro Prieto Geothermal Field, Mexico. I. Hydrothermal mineral zonation. Hoagland, J.R.; Elders, W.A. (Univ. of California, Riverside). pp 283-286 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Hydrothermal mineral assemblages at Cerro Prieto reveal a consistent pattern of progressive response to elevated temperatures. Three stages can be recognized: (1) Diagenetic - low temperature; (2) Illite-chlorite - above 150°C; (3) Calc-aluminum silicate - above 250°C, further subdivided by the first occurrence of epidote at 250°C, of prehnite and actinolite at 300°C and of biotite at 325°C. Below 300°C two other mineral assemblages occur which are not diagnostic of temperature. A zone of quartz and adularia is characteristic of hydrothermal discharge and a zone of calcite +- anhydrite seems to be characteristic of hydrothermal recharge. Mapping these mineral zones across the geothermal field helps to delineate its temperature distribution and hydrology. Somewhat similar mineral assemblages may be recognized in other geothermal fields in the Salton Trough which have formed in similar environments.

40608 Geothermal energy from sedimentary formations of western Canada. Jessop, A.M. (Dept. of Energy Mines and Resources, Ottawa, Canada). pp 331-333 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Two studies of the geothermal potential of the western Canada Sedimentary Basin have been carried out. In the first study the temperature data file was used to delineate the most promising areas for geothermal development. The second study concentrated on three widely separated areas: the Fort Nelson area of northeastern British Columbia, the Calgary area of Alberta, and the north flank of the Williston Basin in southern Saskatchewan. Some details of the study at Regina are presented. (MHR)

40609 Meager Creek geothermal system, British Columbia. Part I: exploration and research program. Nevin, A.E. (Nevin Sadlier-Brown Goodbrand Ltd., Vancouver, British Columbia); Crandall, J.T.; Souther, J.G.; Stauder, J. pp 491-493 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The Meager Creek geothermal area, 150 km north of Vancouver, B.C., centers on a large intermediate Cenozoic volcano. The reservoir systems feeding two independent hot springs on opposite flanks have been partially defined by geologic mapping (Read), resistivity (Shore), shallow drilling, and other operations. Interim conclusions bearing on current exploration are that the targets are water-dominated reservoirs at depths of 1000 to 2000 m in volcanic feeder pipes or nearby open fractures; that natural diffusion from these takes place slowly through weakly permeable fractured quartz diorite "basement"; and that the waters re-equilibrate with low temperature minerals and lose their geochemical memories in transit. The current program leans heavily on a newly developed pole—pole resistivity method (Shore), and is aimed at developing targets for 2000-meter exploratory drill holes.

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

REFER ALSO TO CITATION(S) 40577, 40600, 40608

40610 Recent development of 30 MW Kamojang Geothermal Project, West Java, Indonesia. Basoeki, M.; Radja, V.T. pp 35-38 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Various problems of geothermal energy studies for the development of the Kamojang field in West Java, Indonesia, for the production of 30 MW power plant capacity are discussed. These studies, carried out by the Indonesian Government in cooperation with the New Zealand Government, are primarily based on the information gained during reconnaissance survey, initial investigation, and exploration and production wells testing. Production drilling of ten wells started in 1976 followed by design of structural, mechanical and electrical equipment, and the steam gathering system. The construction of this power plant required approximately 48 months. The jobs occur in three major phases: (1) site development, (2) foundation and building construction, and (3) equipment installation. With the successful production drilling, design and construction of this project, the Indonesian engineers will gain valuable experience.

40611 Lambasa area geothermal investigation, Fiji. Cox, M.E. (Hawaii Inst. of Geophysics, Honolulu). pp 121-123 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Geothermal activity in Fiji occurs at 62 known sites on 7 different islands within the group. On the basis of surface expression and known geochemistry, the Fiji Mineral Resources Division in 1974 selected two areas for detailed investigations. These areas, both on the island of Vanua Levu, appear to present the most potential of all the known geothermal occurrences. Work carried out in one of these areas, the Lambasa area, in the north central part of Vanua Levu, is presented.

40612 Oahu geothermal exploration. Souto, J.M. (Colorado School of Mines, Golden). pp 605-607 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A geophysical reconnaissance of Oahu was carried out over two ancient calderas to evaluate geothermal potential. Electrical resistivity, microseismicity, and soil mercury surveys were carried out. The geothermal potential appears to be favorable in the Koolau caldera where high values of mercury in the soil are present along with low electrical resistivities.

40613 Geothermal energy resources: exploration budgets and costs recovery. Takashima, R.T. (GeoThermal Services, Inc., San Diego, CA). pp 643-644 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Increasing costs of geothermal exploration have made it a necessity that program managers be adequately trained to collect and analyze budgetary data. Exploration budgets should be used to monitor and control dollar expenditures. Furthermore, the program manager must properly utilize the available geothermal exploration techniques with an adequate economic and technical analysis of the acquired data in order to provide a supported determination to continue each exploration venture. Finally, appropriate utilization of cost information should allow geothermal exploration management to make proper decisions as to cost control and calculations of cost recovery.

40614 St. Lucia Geothermal Project. Williamson, K.H.; Wright, E.P. (Inst. of Geological Sciences, London, England). pp 731-733 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The St. Lucia Project is the first geothermal study overseas undertaken by the Institute of Geological Sciences. Studies of the geology and seismicity of the areas were carried out. The object of the investigations was to develop geothermal steam for electric power.

GEOPHYSICAL TECHNIQUES AND SURVEYS

REFER ALSO TO CITATION(S) 40604, 40605

40615 (DOE/ET—28452-2) **Exploration of volcanic geothermal energy resources based on rheological techniques. Second technical status report, June 1, 1978—September 30, 1978.** Bodvarsson, G. (Oregon State Univ., Corvallis (USA). School of Oceanography). 1978. Contract EY-76-S-06-2227-037. 5p. (RLO—2227/T37-2). Dep. NTIS, PC A02/MF A01.

The project objectives are stated. The progress, problems, and future plans are listed briefly. (MHR)

40616 (NVO—0671-2) **Evaluation of lineament analysis as an exploration technique for geothermal energy, western and central Nevada. Final report, June 1976—October 1978.** Trexler, D.T.; Bell, E.J.; Roquemore, G.R. (Nevada Bureau of Mines and Geology, Reno (USA)). Oct 1978. Contract EX-76-S-08-0671. 84p. Dep. NTIS, PC A05/MF A01.

Lineament analysis as an exploration technique for geothermal energy using multi-scale, multi-format imagery and geophysical data is investigated and evaluated. Two areas in Nevada, each having distinct differences in structural style were studied. One area,

which encompasses a portion of the Battle Mountain Heat Flow High, was studied to determine the relationship between regional and local structural controls and geothermal activity. Four geothermal sites within this area (Winnemucca AMS) were selected and studied in detail. These sites include: 1) Leach Hot Springs, 2) Kyle Hot Springs, 3) Beowawe geothermal area and Buffalo Valley Hot Springs. A second area encompassed by the Reno AMS Sheet was selected for further study in a region dominated by three diverse tectonic styles; these are: 1) the Sierra Nevada Front, 2) the Walker Lane, and 3) basin-and-range structures. Geothermal sites analyzed at site specific scales within the Reno AMS Sheet included Steamboat Hot Springs in the Sierra Nevada Front subprovince, Dixie Valley Hot Springs located in typical basin-and-range terrain and the Brady's-Desert Peak area which is marginal to the Walker Lane. Data products employed included LANDSAT imagery, SKYLAB photography, gravity, and aeromagnetic maps. Results of this investigation indicate that in north-central Nevada the major sites of geothermal activity are associated with northeast trending structures related to the Midas Trench lineament and that the most viable geothermal area (Beowawe is located at the intersection of the northeast trend of the Oregon-Nevada Lineament.

40617 Observations of the self-potential effect in geothermal areas in Hawaii and Nevada. Anderson, L.A.; Johnson, G.R. (Geological Survey, Denver, CO). pp 9-12 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

High-amplitude self-potential anomalies of positive polarity are typically found in association with geothermal areas in Hawaii. An electrokinetic process related to the upward movement of pore fluids in both the liquid and steam phases is believed to have caused these anomalies. Self-potential surveys in north-central Nevada produced low-amplitude negative anomalies in those hot spring areas surveyed. These anomalies can also be attributed to an electrokinetic source mechanism but, because of the high conductivity of the pore waters, a mechanism related to the diffusion-potential process is considered to be the more likely cause of the observed negative surface potentials.

40618 Ambient ground-noise measurements and exploration for geothermal resources. Butler, D.; Brown, P.L. (Microgeophysics Corp., Golden, CO). pp 55-58 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Models of geothermal reservoirs which generate seismic emissions include (1) phase changes in the subsurface and (2) a fusion of occurrence times of exceptionally small earthquakes. Another method of detection of subsurface seismic emitters for geothermal exploration is demonstrated. Simulation of this method indicates that uncorrected statics between stations is the principal difficulty in application of the method.

40619 Techniques for interpreting and improving Vp/Vs measurements when assuming a layered geothermal model. Caton, P.W. (Senturion Sciences, Inc., Tulsa, OK). pp 71-74 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

If a geothermal area is modeled as a layered earth and elastic constants vary only with depth, then measured Vp/Vs ratios will depend on microearthquake positions relative to the array as well as focal depths. Vp/Vs ratios obtained from microearthquake data are relationships of apparent P and S phase velocities. An apparent Vp/Vs ratio can represent a medium Vp/Vs value if rays to all stations are through one medium, or if arrivals are critical refractions from a layer at depth. Improved measurements can be obtained when factors contributing to errors in measuring Vp/Vs are understood. In addition to P and S timing precisions, the error in measuring Vp/Vs depends on epicenter position relative to an array with a particular configuration, and the P and S apparent velocities.

40620 Seismic wave attenuation anomalies in the East Mesa Geothermal Field, Imperial Valley, California: preliminary results. Combs, J.; Jarzabek, D. (GeoThermal Services, Inc., San Diego, CA). pp 109-112 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Seismic wave attenuation anomalies are known to be associated with geothermal areas. Data have been analyzed from calibration blasts detonated within the East Mesa Geothermal Field and from six events of the Brawley earthquake swarm of January, 1975, recorded at portable seismic stations deployed in the vicinity of the geothermal field. Alignment of two or more stations of the array with particular epicenters facilitated the removal of source characteristics. Spectral analyses of these calibration shots and earthquake generated seimic waves have shown anomalous attenuation of high frequency P waves along certain ray paths. The results suggest that the source of the heat anomaly responsible for the East Mesa Geothermal Field is located at depths greater than two kilometers and has a lateral extent of several kilometers.

40621 Seismic noise measurements at some geothermal areas in Japan. Ehara, S.; Yuhara, K. (Kyushu Univ., Fukuoka, Japan). pp 171-172 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The seismic noise associated with geothermal activity has been extensively studied at various geothermal areas. However, the physical mechanism of geothermal seismic noise generation is not well-understood quantitatively. Accordingly such seismic technique has not become an established method for geothermal prospecting. But it may be considered that seismic noise analysis in geothermal areas is very useful in order to get information about subsurface physical properties. Especially this method may clear the dynamical aspect of subsurface geothermal activity. From such a view point, seismic noise measurements were conducted at five geothermal areas in Japan. Amplitude of ground particle velocity was measured at a number of points in each geothermal area by using a portable microtremometer and a cassette tape data recorder in order to examine the pattern of seismic noise produced by geothermal activities. At each point, the data were obtained during three minutes. Mean amplitude and power spectral analysis were made for these field data.

40622 Three-dimensional roving dipole interpretation. Frangos, W. (Univ. of Utah Research Inst., Salt Lake City); Hohmann, G.W.; Jiracek, G.R. pp 195-198 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

In order to gain insight into the interpretation of electrical survey data in geothermal prospecting, a library of model results was computed for bipole—dipole and dipole—dipole arrays. This library will be available to the public as a catalog of selected cases. Here some results of resistivity modelling are presented. The purpose is to illustrate typical roving dipole anomalies over conductive bodies, to illustrate the dependence of apparent resistivity on geometry, and to demonstrate the flexibility of the modelling technique.

40623 Magnetotelluric investigations at Mt. Hood, Oregon. Goldstein, N.E.; Mozley, E.; Gamble, T.D.; Morrison, H.F. (Univ. of California, Berkeley). pp 219-221 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The area geology, survey planning, and details of the experimental set-up are reviewed. (MHR)

40624 Topographic effect in resistivity surveys. Hohmann, G.W. (Univ. of Utah, Salt Lake City); Fox, R.C.; Rijo, L. pp 287-290 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Resistivity surveying plays an important role in geothermal exploration and assessment. The usual purpose is to delineate low-resistivity zones that are related to geothermal systems. However, much of the work is carried out in mountainous terrain, where topographic effects can produce similar low-resistivity anomalies. Because topographic effects can be so important in geothermal work, Rijo's (1977) two-dimensional finite element program was used to conduct a systematic study. Topography can be simulated readily with the finite element method due to the flexibility of the triangular elements used. Comparison with a three-dimensional scale model shows that two-dimensional analysis is adequate, though the next step will be to calculate results for three-dimensional topography (much more expensive) when a computer program becomes available. Only the dipole—dipole array was studied because of its resolution, field efficiency, and common usage in geothermal work.

40625 Teleseismic P-delays at the Geysers-Clear Lake, California geothermal region. Iyer, H.M.; Oppenheimer, D.H.; Hitchcock, T. (Geological Survey, Menlo Park, CA). pp 317-319 of Geothermal

energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The Geysers-Clear Lake geothermal field, site of the only commercial geothermal power facility in the U.S.A., is located 130 km north of San Francisco, California. Twenty-four teleseisms recorded during 1976 and 1977 by the U.S. Geological Survey telemetered seismic network in The Geysers-Clear Lake region were analyzed for teleseismic residuals (P-delays). In addition to this permanent seismic network, a northwesterly profile of fourteen portable seismic stations recorded twenty-four teleseisms from July, 1976 to September, 1976. The results of this investigation suggest that the teleseismic residual technique may be useful in delineating the presumed magmatic heat source in The Geysers region.

40626 Results of electric survey in the area of Hawaii geothermal test well HGP-A. Kauahikaua, J. (Geological Survey, Denver, CO); Klein, D. pp 363-366 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Between 1973 and 1976, the Hawaii Institute of Geophysics made five Schlumberger-type soundings, two bipole mapping surveys, a dipole—dipole pseudo-cross section, and fifteen line-loop transient soundings in the Puna district on the Island of Hawaii (Kauahikaua and Klein, 1977a and b). The Schlumberger and transient sounding data were inverted for a best-fitting layered-earth model to define resistivity variations with depth. The soundings allow qualitative separation of the effects of lateral resistivity variations from those of vertical variations in the bipole mapping data. The accumulated data suggest that all the near-surface lavas are highly resistive (6000 to 8000 ohm-m), but that the lavas below sea level are fairly conductive. However, a distinct lateral resistivity variation exists in the substratum. Resistivities range from 100 to 300 ohm-m along Kilauea volcano's rift zone and from 6 to 10 ohm-m between the rift and the coast. Superimposed on this pattern are an anomalous, low-resistivity area within the rift zone and one within the coastal area that may be related to geothermal activity. A successful test hole, drilled to nearly 2000 m in depth, is situated within one of these anomalies.

40627 Honey Lake KGRA geophysical survey and drilling tests. Pritchard, J.I. (Electrodyne Surveys, Sparks, NV); Zebal, G.P. pp 545-546 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

An integrated geophysical survey of the Honey Lake, California KGRA was conducted to aid in the evaluation of the geothermal resource potential that exists in the vicinity of the Wendel Hot Springs. The geophysical survey was divided into a reconnaissance and a detailing phase. Four types of geophysical methods were employed during the reconnaissance phase: gravity, ground magnetics, scalar AMT—MT (audio-magneto-telluric and magnetotelluric) soundings and tensor MT soundings. A detailed electrical resistivity survey was conducted utilizing the Electro-Sonde profiling technique. (MHR)

40628 Meager Creek geothermal system, British Columbia. Part III: resistivity methods and results. Shore, G.A. (Deep Grid Analysis Ltd., Vancouver, British Columbia). pp 593-596 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Electrical resistivity survey has been the principal geophysical exploration tool applied at Meager Creek geothermal area, 150 km north of Vancouver, B.C. Dipole—dipole reconnaissance traverses have been successful in identifying areas of anomalous resistivity in the accessible valley areas around the volcanic complex. Extremely steep topography imposes severe spatial constraints on the layout of long-spacing arrays, and impedes anomaly examination and resolution. A multiple pole—pole array addressed by a computer-based scanning receiver is being employed to increase effective penetration within the limited operating space and to provide a multidirectional data base for anisotropy studies.

40629 Computer program for calculating theoretical curves and it's application to VES data in geothermal areas. Ushijima, K.; Ushijima, K. (Kyushu Univ., Fukuoka, Japan). pp 671-674 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

In order to interpret Vertical Electrical Soundings (VES) data obtained in geothermal areas, a complete curve matching method may be used on the condition that the subsurface of the area is a horizontally layered structure. The PSH-B program and its practical application to the VES curves obtained in Otake and Takenoyu geothermal fields of Japan are described.

40630 Magnetotelluric observations at the Roosevelt Hot Springs KGRA and Mineral Mts., Utah. Wannamaker, P.E.; Sill, W.R.; Ward, S.H. (Univ. of Utah, Salt Lake City). pp 697-700 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Twenty-five magnetotelluric soundings in the Roosevelt Hot Springs area indicate a very complicated, three-dimensional electrical environment. The assembly of a profile of one-dimensional transverse electric inversion interpretations yields a calculated 2-D apparent resistivity-frequency pseudosection far removed from the observed data. Trial-and-error modeling improves the fit only a little. The most notable difficulty, the presence in both TE and TM pseudosections of pronounced contrasts in rho/sub a/ persisting to the lowest observed frequency, may be explained by the discontinuities in electric field that are found for all directions of wave excitation for 3-D geometries. The estimation of electrical strike is also difficult in the 3-D case since the total fields do not decompose into the two principal excitation modes. Whenever a plane of symmetry exists, the estimated electrical strike will be normal to it; otherwise an oblique estimation results. The observed consistency of strike estimation at Roosevelt is likely due to the gross, elongate, resistive horst structure of the Mineral Mts. in surrounding conductive valley fill. Mode identification and the effects of near-surface 3D inhomogeneities pose potential major limitations to the magnetotelluric method.

40631 Combined electromagnetic and galvanic (d.c.) electrical resistivity soundings. West, R.C.; Pritchard, J.I. (Electrodyne Surveys, Sparks, NV). pp 713-716 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A new combination of three of the basic electrical methods: galvanic, controlled source electromagnetic, and telluric profiling methods is suggested as an alternative detailing tool to the magnetotelluric method which can provide less ambiguous results at a reasonable cost. This combined method will be referred to as Electro-Sonde Profiling (ESP). This method is described and its advantages are listed. (MHR)

40632 2-D inversion of seismic attenuation observations in Coso Hot Springs, KGRA. Young, C.Y.; Ward, R.W. (Univ. of Texas at Dallas, Richardson). pp 743-746 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Seismograms from over sixty teleseismic events recorded by a sixteen element vertical component telemetered seismograph array installed by the U.S. Geological Survey in the Coso Hot Springs, Known Geothermal Resource Area (KGRA) have been analyzed to determine the lateral variation of seismic attenuation using the reduced spectral ratio technique. Seismograms of events from the SE and NW azimuths observed at a five station linear array have been used to infer a 2-D Q^{-1} model across the center of the geothermal system. A constrained generalized linear inversion algorithm was used to infer the Q^{-1} model. The model contains 15 cells with boundaries at depths of 5, 20, and 33 km and Q variations from 32 to 890. The zone of high attenuation dips from the surface between Coso Hot Springs and Airport Lake toward the northwest beneath Devil's Kitchen.

GEOCHEMICAL TECHNIQUES AND SURVEYS

REFER ALSO TO CITATION(S) 40593, 40595, 40601

40633 (LBL—7092) **Geochemical studies of rocks, water, and gases at Mt. Hood, Oregon.** Wollenberg, H.A.; Bowen, R.E.; Bowman, H.R.; Strisower, B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Feb 1979. Contract W-7405-ENG-48. 66p. Dep. NTIS, PC A04/MF A01.

Mr. Hood, a composite andesitic volcano, located near Portland, Oregon, is one of several large eruptive centers which dominate the Cascade Mountains of the western United States. As part of a program of geologic, geophysical and geochemical studies to examine Mt. Hood's geothermal resource potential, samples of warm-and cold-spring water, water from a geothermal test well in

Old Maid Flat, fumarolic gases, and rocks were collected and analyzed for major chemical constituents and trace elements. The only warm-spring area on Mt. Hood is Swim Springs, located on the south flank. Orifices at Swim were sampled repeatedly with little overall change noted in water chemistry between summer and winter. Oxygen and hydrogen isotope data and mixing calculations based on analyses of Swim Springs and numerous cold springs, indicate that a large component of the warm water at Swim is from near-surface runoff. Chemical geothermometry suggests that temperatures at depth in the Swim Springs system are within the range 104 to 170°C; the temperature of unmixed hot water may exceed 200°C. Higher-than-background chloride contents and specific conductances of cold springs on the south flank of the mountain suggest that there is a small component of thermal water in these sources. A geothermal model of Mt. Hood is proposed wherein snow- and glacier-melt water near the summit comes in close promimity to the hot central neck of the mountain, manifested by the summit-crater fumaroles.Iridium was detected in warm and cold spring waters and in a sample of altered andesite.

40634 Problems in estimation of salinity profile in liquid dominated geothermal systems. Ershaghi, I.; Dougherty, E.L.; Ucok, H.; Ghassemi, F. (Univ. of Southern California, Los Angeles). pp 181-183 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Estimation of salinity profile in producing geothermal wells is of great importance in subsurface mapping and in designing the well completion. Well logs have traditionally been used to estimate R/sub w/ and, hence salinity, in sedimentary type oil field reservoirs. Geothermal reservoirs introduce complexities which can lead to errors in interpretation of well log data using existing oil field correlations. Certain aspects of the problem with examples from the Cerro Prieto field in Mexico are reviewed.

40635 Influence of P/sub CO_2/, salinity, and bedrock type on the Na—K—Ca geothermometer as applied in the Clear Lake Geothermal Region, California. Goff, F.E. (Los Alamos Scientific Lab., NM); Donnelly, J.M. pp 211-214 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Variations in estimated temperatures based on Na—K—Ca geothermometry have been investigated as functions of P/sub CO_2/, salinity, and bedrock type for 45 thermal/mineral waters issuing in the Clear Lake geothermal province. Although many of the waters are rich in HCO_3^- and CO_2, the geothermometer is independent of P/sub CO_2/. On the other hand, the geothermometer is strongly influenced by salinity which is in part controlled by the bedrock type in the Clear Lake Region.

40636 Chemical analysis of water from the world's first geopressured-geothermal well. Hankins, B.E.; Chavanne, R.E.; Ham, R.A.; Karkalits, O.C.; Palermo, J.I. (McNeese State Univ., Lake Charles, LA). pp 253-256 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A chemical analysis of geopressured water from a shut-in gas well which penetrated the geopressured zone is discussed. Density, viscosity, dissolved solids, iron, sulfate, barium, dissolved silicate, suspended solids, bicarbonate, pH, total hardness, specific conductance, chloride, copper, manganese, zinc, boron, arsenic, chromium, mercury, lead, cadmium, strontium, sodium, potassium, calcium, and magnesium determinations were performed. (MHR)

40637 Chemical analysis of dissolved natural gas in water from the world's first geopressured geothermal well. Karkalits, O.C.; Hankins, B.E. (McNeese State Univ., Lake Charles, LA). pp 351-354 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The experimental equipment methods and results are reviewed. It is concluded that the waters from sand-bed aquifers No. 1 and No. 3 are substantially saturated with respect to natural gas at the pressure and temperature existing in the aquifers. Also, the solubility of methane in saline waters, containing 11 to 14% total dissolved solids, is reduced by 35 to 50% over that which it would have had in pure water at reservoir conditions. (MHR)

40638 Chemistry of waters in the geopressured zone from coastal Louisiana: implications for the geothermal development. Kharaka, Y.K.; Brown, P.M.; Carothers, W.W. (Geological Survey, Menlo Park, CA). pp 371-374 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Detailed chemical analyses of 27 formation-water samples from 7 oil and gas fields in the Lafayette area, Louisiana, show that the salinity of water in the geopressured zone ranges from about 22,000 to 275,000 mg/L dissolved solids. The large differences in the salinity of water in the geopressured zone from different fields result mainly from interaction of water with salt beds. The concentrations of H_2S (<1 mg/L), silica (<114 mg/L), and a number of toxic trace metals are low in the geopressured geothermal waters. The relatively high salinity of these waters, however, and the moderately high concentration of environmentally toxic components (boron, up to 69 mg/L, and ammonia, up to 100 mg/L, for example) are unfavorable to geothermal development. The chemical data indicate that careful evaluation of the compatibility of the spent geothermal waters and the waters in the formations used for injection will be required to minimize loss of porosity due to precipitation of carbonates and sulfates of Ca, Sr, and Ba.

40639 Geochemistry of a Hawaii Geothermal Well: HGP-A. pp 375-377 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Kroopnick, P.M. (Univ. of Hawaii, Honolulu); Lau, L.S.; Buddemeier, R.W.; Thomas, D. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Extensive sampling and analysis have been carried out on the Hawaii Geothermal Project well-A (HGP-A) over a period of 12 months beginning in July 1976. Samples of the following types have been taken: downhole samples taken with a Klyne thief sampler, steam-condensate samples taken at the well head with a double cyclone separator and effluent water samples taken at the outlet of the steam silencer. Water quality analyses have included the following: Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, S^{2-}, SiO_2, alkalinity and pH. Age dating of the well waters was done by ^3H analysis and ^{14}C analysis of CO_2 in the discharge gases. The results of the water quality analysis made on downhole water samples are summarized, included also is the statistical profile of the data. The salient features of the data obtained are described.

40640 Radon in geothermal reservoir engineering. Kruger, P. (Stanford Univ., CA). pp 383-385 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Radon transient analysis appears promising as a method complementary to pressure transient analysis in the assessment of geothermal reservoirs. Measurement of radon is proving useful in two types of studies in geothermal reservoir engineering: (1) examining the structural properties of the reservoir as they affect the emanation of radon from rock to pore fluids and (2) examining the flow properties of the reservoir as they affect radon migration. Several radon transient tests have been conducted to examine the relationship between radon concentration in wellhead condensate and changes in flowrate. The results indicate that details of reservoir structure and transport may be examined with radon as an internal reservoir tracer.

40641 Hydrocarbon gases in some volcanic and geothermal systems. Nehring, N.L.; Truesdell, A.H. (Geological Survey, Menlo Park, CA). pp 483-486 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The analysis of hydrocarbon gases in volcanic and geothermal systems has traditionally been limited to methane and occasionally ethane. Stoiber, et al. (1971) analyzed three gas samples from a fumarole on Santiaquitio Volcano, Guatemala and identified a wide range of organic compounds including aliphatic and aromatic hydrocarbons, aldehydes, ketones, alcohols, halogenated hydrocarbons, and sulfur compounds. Gunter (1978) analyzed several samples from Yellowstone National Park for the C-1 to C-4 hydrocarbons. The normal alkanes, isobutane, ethene, and propene were identified. The present work reports on the analysis of C-1 to C-6 hydrocarbons, including normal and branched alkanes, alkenes, and cyclic compounds, from a variety of volcanic and geothermal systems.

40642 Hydrothermal mineralogy and isotopic geochemistry in the Cerro Prieto Geothermal Field. II. Isotopic geochemistry. Olson, E.R.; Elders, W.A. (Univ. of California, Riverside). pp 513-516 of Geothermal energy: a novelty becomes resource. Transactions.

Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Stable isotope measurements on borehole samples from Cerro Prieto provide estimates of temperature and water-rock ratios (W/R) in the geothermal system. Shales normally have lower W/R in some wells. The best samples for temperature calculations are hydrothermal vein minerals. The isotopic measurements have aided current exploration at Cerro Prieto. For example, no temperature log could be run deeper than 1800 meters in exploration well M92, but isotopic temperatures indicate only 200°C at 2500 meters. In addition isotopic temperatures and wide W/R ranges in wells M91 and M92 suggest that they lie at the probable margin of the productive field. In the center of the field light oxygen del values for the produced fluid appear to delineate extensive drawdown. Similar studies could assist geothermal exploration elsewhere, and provide baseline information to monitor the effects of production.

40643 Chemical characterization of gases and volatile heavy metals in geothermal effluents. Robertson, D.E.; Fruchter, J.S.; Ludwick, J.D.; Wilkerson, C.L.; Crecelius, E.A.; Evans, J.C. (Battelle Pacific Northwest Labs., Richland, WA). pp 579-582 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Noxious gases and heavy metals released in effluents from two geothermal power plants and numerous test facilities have been characterized. These areas include The Geysers, CA; Cerro Prieto, Baja, CA; Raft River, Idaho; Tigre Lagoon, Louisiana; and the Imperial Valley, CA sites at Niland, East Mesa and Heber. Some of the results of the chemical characterizations of geothermal effluents are summarized. To chemically characterize and quantify the geothermal gases and trace elements in geothermal well effluents, and to establish mass balances of these constituents entering and leaving the power plants, samples of incoming steam were condensed and the condensates and noncondensable gases were sampled. The power plant effluents consisting of cooling tower waters, cooling tower exhaust air, ejector off-gases, and brine waters were also collected for analyses. The following chemical constituents are reviewed: H_2S, Hg, As, B, NH_3, and radon-222.

40644 Use of the random groundwater data from WATSTORE in geothermal exploration: an example from the Imperial Valley, California. Swanberg, C.A.; Alexander, S. (New Mexico State Univ., Carlsbad). pp 635-638 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

On the basis of about 500 groundwaters from the Imperial Valley of California, supplemented by about 8,000 groundwaters from adjacent parts of the Basin and Range province, the normal ranges of various chemical geothermal indicators and the criteria by which geothermal waters can be recognized were established. For the Imperial Valley and the southern Basin and Range province, we propose the following values as potentially signifying geothermal waters: silica geotemperature >100°C, Na—K—Ca geotemperature >125°C, fluoride >2.5 ppM, in situ temperature >35°C, and heat flow >120 mWm^{-2}. Application of the above criteria to groundwater data from the Imperial Valley and the southern Basin and Range province has lead to the rediscovery of most known thermal areas and the delineation of an equal number of promising new target areas.

40645 Isotopes and gases in a Hawaiian geothermal system: HGP-A. Thomas, D.; Kroopnick, P.M. (Univ. of Hawaii, Honolulu). pp 653-654 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Gases from the Hawaii Geothermal Project well-A (HGP-A) were sampled over the course of twelve months to determine their isotopic and chemical composition. Samples of steam and gas were collected and condensed at the wellhead through a twin cyclone steam/water separator during steam discharge of the well. Gas separations were carried out on standard gas chromatographic columns with thermistor and mass spectrometric detection of the chromatogram peaks. Isotopic analyses were carried out on several individual components of the gas phase: CO_2 ($\delta\ ^{13}C$), N_2, He, H_2O ($\delta\ ^{18}O$).

EXPLORATORY DRILLING AND WELL LOGGING

REFER ALSO TO CITATION(S) 40580, 40596, 40734, 40736

40646 (CONF-790415—17) **Chemical logging of geothermal wells.** McAtee, R.E.; Allen, C.A.; Lewis, L.C. (Idaho National Engineering Lab., Idaho Falls (USA)). Apr 1979. Contract EY-76-C-07-1570. 21p. Dep. NTIS, PC A02/MF A01.

From 177. ACS national meeting; Honolulu, HI, USA (1 Apr 1979).

The determination of the change in chemical composition of the diluted drill fluid and its separation from the chemical background contributed by the drill fluid, drill mud, and other aquifer leakage is the essence of the chemical log. Samples of the drill fluid were collected for chemical analysis at certain times during the drilling operations. The chemical logging study of the geothermal wells is described. (MHR)

40647 (SAND—78-1550C) **Development of a high resolution downhole pressure instrument for high temperature applications.** Eernisse, E.P.; McConnell, T.D.; Veneruso, A.F. (Sandia Labs., Albuquerque, NM (USA)). 1978. Contract EY-76-C-04-0789. 6p. (CONF-7810170—1). Dep. NTIS, MF/A01.

From 2. international well-testing symposium; Berkeley, CA, USA (25 Oct 1978).

As part of the Geothermal Logging Instrumentation Development Program being conducted by Sandia Laboratories for the Department of Energy's Division of Geothermal Energy, high resolution, quartz crystal based, downhole pressure instruments are being developed. Under a joint no-cost contract, Sandia and Paroscientific, Inc., of Redmond, Washington, are working to upgrade a Paroscientific transducer for operation at 275°C. In addition, Sandia Laboratories has been investigating various design configurations and fabrication techniques for high temperature quartz resonators and their associated electronic circuits. The goal of these efforts is to achieve a resolution of 0.01 psi in a 0 to 7000 psi range and in temperatures up to 275°C. The progress and plans for this project will be reviewed and hardware samples will be displayed.

40648 Use of shallow and deep temperature gradients in geothermal exploration in northwestern Nevada using the desert peak thermal anomaly as a model. Benoit, W.R. (Phillips Petroleum Co., Reno, NV). pp 45-46 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The Desert Peak thermal anomaly is located about 50 miles east of Reno, Nevada. It was discovered while drilling temperature-gradient holes near Brady's Hot Springs. This anomaly covers about 100 square miles, making it the largest known thermal anomaly in Nevada. It has a complex outline as it is a composite feature over at least two apparently separate thermal systems. The internal structure is also complex and intense with temperature gradients of from 30 to 60°F/100 feet being common in the heart of the anomaly. Fifty-four temperature-gradient holes deeper than 180 feet have been drilled by Phillips Petroleum to define this anomaly.

40649 Comparison of surface and downhole resistivity mapping of geothermal reservoirs in New Mexico. Jiracek, G.R.; Gerety, M.T. (Univ. of New Mexico, Albuquerque). pp 335-336 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Electrical resistivity measurements performed using an electrode downhole in a geothermal discovery well may offer an improved technique for reservoir assessment. The principle is that electrical current introduced directly into the conductive geothermal reservoir will experience more pronounced channeling compared to current from a surface source. Such a technique has been successfully applied in evaluating mining prospects and initial tests have been recently made at two geothermal sites in New Mexico.

40650 Transient temperature inversions in geothermal boreholes. Lowell, R.P.; Chen, C.H.; Fulford, J.K. (Georgia Inst. of Tech., Atlanta). pp 407-409 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Some simple models are given for the generation of temperature inversions which may result from the injection of drilling fluid into a formation and the subsequent relaxation of such inversions after drilling ceases.

40651 Drilling and directional drilling a moderate-temperature geothermal resource. Miller, L.G.; Prestwich, S.M.; Gould, R.W. (EG and G Idaho, Inc., Idaho Falls). pp 455-456 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Three production and two injection wells have been drilled in the Raft River Valley. The techniques used in the drilling and testing of these high-fluid-volume wells are described. (MHR)

40652 Geologic exploration methods for siting power plants and other structures in landslide and hydrothermally altered terrain at The Geysers, California. Ridley, A.P. (Woodward-Clyde Consultants, San Francisco, CA); Vantine, J.V. pp 563-565 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The assessment of foundation conditions should consider the presence of landslide conditions and hydrothermally altered rock in the steep terrain at The Geysers. The usual methods were used: aerial photograph interpretation, detailed geologic mapping with modifications of methods such as seismic refraction surveys, and shallow exploration drilling and trenching. (MHR)

40653 East Mesa geothermal anomaly, Imperial County, California: significance of temperatures in a deep drill hole near thermal equilibrium. Urban, T.C.; Diment, W.H.; Nathenson, M. (Geological Survey, Menlo Park, CA). pp 667-670 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Precision temperature logs were obtained in U.S. Bureau of Reclamation drillhole Mesa 31-1 (32°48.6'N,115°15.7'W) at East Mesa to a depth of 1880 m. Comparison of logs taken some two months apart and nearly a year after the production testing suggests the hole is close to thermal equilibrium. The thermal regime of the hole is characterized (1) by high gradients which predominate in the conductive cap (0 to 840 m) and are affected by hydrologic disturbances to at least 150 m, (2) by a sharp decrease in gradient at the base of the cap (~ 840 m), (3) by a uniformly low gradient (~ 40°C/km) below the cap except near the perforated zones (below 1650 m), and (4) by small convective motions within the hole as indicated by temperature-time recordings. The observed low gradient below the cap does not necessarily imply convection in a thick permeable medium. Instead, simple numerical models suggest the gradient could be the result of conductive heating from a hot permeable zone maintained by horizontal water movement near the base of the cap.

40654 Acoustic sensor development for geothermal borehole televiewer. Wonn, J.W. (Westinghouse R and D Center, Pittsburgh, PA). pp 735-738 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The Borehole Televiewer (BHTV) is a well logging tool which provides an acoustic image of the borehole surface, delineating such important features as wall discontinuities, formation dip, fracture patterns, vugs, and washouts. Demonstrated capabilities include mapping of fracture zones, bedding planes, and other borehole manifestations of the geology. BHTV has also been used in cased wells as an inspection tool to map cavitation, pitting, perforation plugging or enlargement, casing breaches, and other production-related parameters. Field evaluations of BHTV have been conducted in geothermal reservoirs for some time. Cooperative efforts with Simplec have resulted in an improved BHTV with extended temperature tolerance. However, efforts to operate the improved tool at temperatures as high as 500°F have been largely unsuccessful to date. The most serious geothermal tool deficiencies appear to be concentrated in the acoustic sensor portion of the tool, as it must withstand direct exposure to the borehole fluid. Westinghouse is currently developing a geothermal BHTV sensor. Environmental design goals are operating at 275°C (525°F) and 7000 psi and sufficient tolerance to the corrosive borehole fluid. The objective is to demonstrate the operation of a BHTV sensor under simulated geothermal borehole conditions. The developed sensor configuration will follow that of the improved BHTV sensor package so that the resulting technology can be readily incorporated into an experimental geothermal BHTV design. The sensor problems, development program plan, facilities, materials and components evaluated, autoclave test cycle, and project status and results are reviewed.

LEGAL AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 40680, 40692, 40763

40655 Local government management of geothermal resources. Anglin, R.L. Jr. (Jet Propulsion Lab., Pasadena, CA). pp 13-19 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Potential policy options for regulation of geothermal resources by local government may be conceptualized along a continuum from no regulation to total regulation of the industry. The practical lower limit is regulation of nuisance impacts such as pollutant emissions, noise, and the like. Options along the regulatory continuum may be grouped roughly into two categories based on the information required to regulate surface manifestations of geothermal development versus that required to control the resource itself. Management scenarios controlling the resource itself form the practical upper limit on local government regulation of geothermal resources. Local government must carefully balance the benefits to be derived from seeking to control the resource itself against the costs of that regulation. It is not clear that local government should or can impose regulations on use of the resource itself. The purpose of this paper is to examine geothermal regulatory options both desirable and appropriate for local government. Two illustrative examples are discussed.

40656 Environmental response to non-electric geothermal energy: an attitudinal assessment. Beauchamp, E.L. pp 39-41 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

In the assessment of potential environmental impacts of technological change, it is increasingly important to assess public attitude about such change. Typically, public attitude surveys use questions directed toward a specific issue. As part of the engineering and economic assessment of potential utilization of geothermal energy for non-electric applications in the City of Desert Hot Springs, California, an attempt was made to assess basic attitudes and values toward the environment as an indication of community acceptance of increased use of the resource. This was accomplished using the Environmental Response Inventory (ERI), an attitudinal assessment inventory, in conjunction with an item-specific attitude survey. The results indicated that both city officials and the general public fundamentally endorsed technological development. The results of the ERI in the City of Desert Hot Springs are presented and the implications of its use are assessed in evaluating implementation of energy technology.

40657 U.S. Forest Service considerations for geothermal leasing in the Island Park area. Beland, J.M.; Ferebauer, J.R.; McGee, J.M.; Szczepanowski, S.P. (U.S. Forest Service, St. Anthony, ID). pp 43-44 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

40658 Federal geothermal leasing program, 1974—78. Bickmore, D.K.; Bull, K.W. (Geological Survey, Menlo Park, CA). pp 47-49 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The statistical data and other information concerning leases and operations on Federal lands in this report augment that presented last year by Stone (1977). The year 1978 marks the 5th year of exploration and development of geothermal energy on Federal lands, contrasting with more than 20 years on private lands in the United States, and at least 70 years worldwide. Several agencies work together to ensure a successful leasing program. On Federal geothermal leases, the USGS supervises exploration, development, and production. USGS personnel review and approve plans of operation, prepare environmental assessments of proposed operations, issue permits, perform lease inspections, and collect royalties. The USGS advises the Bureau of Land Management (BLM) regarding geothermal resource values on lands to be offered at competitive lease sales. The BLM issues leases and oversees exploration on unleased Federal lands. However, other land-management agencies - e.g., the U.S. Forest Service (USFS) - supervise exploration on unleased lands that they administer.

40659 Concepts in utilization of Federal geothermal leases. Cargill, K. (Geological Survey, Menlo Park, CA); Conover, R.D. pp 67-70 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Some of the concepts of unitization are presented to help the operator understand what to expect from a Federal unit agreement. Federal units are authorized for geothermal resources under the Geothermal Steam Act of 1970, and are provided for in detail in the regulations. Guidelines and procedures for preparation of agreements and formation of units are available from the Office of the Area Geothermal Supervisor, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, CA 94025.

40660 Direct applications of geothermal energy technical assistance program. Donovan, L.E. (Idaho National Engineering Lab., Idaho Falls); Griffith, J.L.; Schultz, R.J.; Wright, P.M. pp 161-162 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The objective of the technical assistance program is to foster geothermal energy use. The strategy of this program is to act as a catalytic agent by providing technical assistance to the general public, industry, DOE contractors, and federal and state/local agencies on a request basis. Technical assistance is given in consultation format, with priorities for assistance requests from industry and the general public established on a first-come basis. Most output takes the form of technical advice. The program was developed around the thesis that there are many individuals or groups with available geothermal resources who do not know how to initiate the user role. The chronological case history of one of the early technical assistance contacts, which is now nearing the final stages of fruition, is outlined.

40661 Institutional policy and planning issues in geothermal development: the case of Imperial County. Edmunds, S.W. (Univ. of California, Riverside). pp 167-170 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The institutional issues of geothermal development may be analyzed by research which relates resource and engineering assessments to the interests, benefits and costs, associated with a geothermal resource, as they impact various institutional constituencies, like the developers, utilities, county government, agriculturalists, citizens, or unemployed. The sum of the benefits, in the Imperial County case, significantly exceeds costs; and the institutional issues center mainly upon environmental abatement, income distribution effects, and land use. How these institutional issues can be resolved by policy and planning is illustrated.

40662 Geothermal resource development and wilderness preservation in Oregon and California. McNamara, J.; Elmer, D. (Univ. of Southern California Law Center, Los Angeles). pp 427-429 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

In many areas of Oregon and California, wilderness study and evaluation has precluded even passive exploration for geothermal resources. This paper attempts to identify the precise areas of perceived conflict between geothermal development and wilderness study and evaluation and suggests a possible resolution.

40663 Regulatory process confronting geothermal development in California: can we burn the paper mountain. McNamara, J. pp 431-432 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Geothermal developers have long complained of the seemingly needless red tape that they must undergo in California. The sum of these requirements has been dubbed the "Paper Mountain." California's regulatory requirements are examined and reforms recently suggested by the State Geothermal Resources Task Force and the State Energy Commission are proposed.

40664 Methodology of socioeconomic impact assessments of geothermal energy development. Meidav, M.Z. (Kendall Associates, San Francisco, CA). pp 433-436 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Discussions are included on the following topics: conditions of appropriate response to proposed projects, procedures, socioeconomic impacts of geothermal energy development, socio-political realities, sources of data, and methodological approaches. (MHR)

40665 Federal geothermal lease bidding. Oden, H.A.; Mac Gillvray, T.J.; Lohrenz, J. (Geological Survey, Reston, VA). pp 509-511 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The four-year bonus bidding history for Federal geothermal leases is compared with the longer history of bidding for Federal offshore oil and gas leases. Differences and similarities were found, the more interesting of the latter were: (1) the standard deviation of bids for a lease appeared to be about the same for both types of leases, and (2) the fraction of money left on the table was almost exactly the same. These similarities arose even though offshore oil and gas lease bids were orders of magnitude higher than geothermal bids.

40666 Role of the U.S. Geological Survey in the Federal Leasing Program. Stone, R.T.; Cullins, H.L.; Crittenden, M.D. (Geological Survey, Menlo Park, CA). pp 617-621 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Major agency coordination efforts in lease management responsibilities are summarized. Major geological survey elements and their relationship to leasing responsibilities are identified. (MHR)

ECONOMIC AND FINANCIAL ASPECTS

REFER ALSO TO CITATION(S) 40693, 40761

40667 Approach to risk analysis for government-sponsored demonstration projects. Dhillon, H.; El-Sawy, A. (MITRE Corp., McLean, VA). pp 153-156 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The economics of geothermal power plant demonstration is analyzed from the view points of the government and the private industry organizations participating in these demonstrations. The analysis presented focusses on electric power plants only, and a similar approach can be adopted for evaluating the demonstrations of direct-utilization alternatives.

40668 New concept in geothermal steam pricing. Jenkins, C.B. (Aminoil USA, Inc., Houston, TX). pp 327-329 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Steam in the Geysers is being sold at a price determined by a relatively complicated formula which calculates a price for steam based upon the prior year's fuel cost for fossil and nuclear fuel alternatives. This pricing formula contains a number of discriminatory features in regards to geothermal energy pricing including several built-in discounts and an inappropriate comparison of fuel costs instead of bus-bar costs. At the time that this pricing formula was negotiated, there was an adequate supply of hydro power, a plentiful supply of cheap gas and oil, and a strictly "buyers" market for steam. The geothermal pricing formula suggested recognizes that this situation has changed and attempts to price geothermal steam on an equitable basis with a utility company's alternative cost in using other electrical power energy sources; i.e., oil, coal, nuclear.

40669 Geothermal energy direct applications market-estimator model. Metzger, S.W. (Idaho National Engineering Lab., Idaho Falls). pp 437-439 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The subject model, which can best be described as a marketing economics tool, was conceived on the premise that a "quick and dirty" estimation technique often provides an acceptable degree of perception into the basic character of a market. This rather superficial calibration of a market could be considered in lieu of the data a more expensive, in-depth investigation would produce. The value of this market-estimator model will be dependent, however, upon the resources available to the researcher. Moreover, the model's value will be contingent upon the desired quality of data upon which a decision, either preliminary or final, will be based. The model is ideal

for those situations which depict limited study resources and permit "order-of-magnitude" assessments. It is hypothesized by the author that most market decisions within, or without the geothermal community, are formulated with less than complete and accurate data which are obtained through less than optimum resource means.

40670 Private sector in hydrothermal resource development. Rodzianko, P. (Geothermal Energy Corp., New York). pp 583-585 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The considerations outlined point out the need for the private sector to learn from past successful geothermal development experiences and thus minimize front-end field investment in anticipation of smaller initial unit sizes. The following constraints and considerations are discussed: impact of field investment, reservoir risk, base load reliability, resource utilization, and utility financing constraints. A recommendation and implementation technique are included. (MHR)

40671 Busbar economics of liquid-dominated geothermal power. Wassenaar, J.A. (Fugro, Inc., Long Beach, CA). pp 703-707 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The following variables in the cost of hot-water geothermal power are discussed: plant utility factor, conversion cycle efficiency, fuel (heat) price, capital cost, resource longevity, operations and maintenance cost, and power transmission cost. (MHR)

ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL

REFER ALSO TO CITATION(S) 40182, 40643, 40655, 40656, 40661, 41621

40672 Preliminary appreciation of effects on aquatic environments of geothermal power development in New Zealand. Coulter, G.W. (Dept. of Scientific and Industrial Research, Taupo, New Zealand). pp 119-120 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The effects of silica and arsenic levels on aquatic ecosystems on the Waikato River are reviewed. Thermal and trace element effects are mentioned. (MHR)

40673 EPA pollution control guidance for the geothermal industry. D'Alessio, G.J.; Hartley, R. pp 133-135 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The EPA regulatory approach is reviewed. Efforts in the following areas are covered: air pollution, water pollution, groundwater pollution, land-disposal wastes, noise, and radiological pollutants. Future limitations on air pollutants, water pollutants, and noise are discussed. Future development of effluent and emission standards is discussed. (MHR)

40674 Disposal of liquid effluents from geothermal installations. Defferding, L.J.; Walter, R.A. (Battelle Pacific Northwest Lab., Richland, WA). pp 141-144 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The disposal of spent geothermal fluids from power plants and nonelectric installations is a major expense to the resource developer. Subsurface injection, the most favored of all disposal options, accounts for 10 to 20% of the cost of power from a binary fluid cycle power plant. The disposal of liquid effluents has been successfully demonstrated at a number of geothermal sites but numerous technological difficulties must often be overcome, including hostile fluid chemistry, large disposal volumes, adverse environmental impacts, the site-specific nature of each geothermal resource, and the lack of geothermal reservoir definition. A summary of the applicability of various disposal options is provided. A number of areas are identified where additional work on disposal can result in more economical and reliable disposal systems.

40675 Air quality assessment studies of geothermal development in the Imperial Valley. Gudiksen, P.H.; Axelrod, M.C.; Ermak, D.L.; Lamson, K.C.; Nyholm, R.A. (Univ. of California, Livermore). pp 235-236 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

An assessment of the potential environmental impact of developing the geothermal resources of the Imperial Valley is presently being carried out by the Imperial Valley Environmental Project to ensure that the development may proceed in an environmentally sound manner. An integral part of this project is the evaluation of the potential impact of this development on the air quality of the valley. Geothermal power generation may release a variety of gaseous substances to the atmosphere. The principal gas of concern is H_2S, but other gaseous species such as NH_3, CO_2, CH_4, Hg, and Rn may also be released. To evaluate this impact, the air quality element is currently addressing the following tasks: baseline air quality measurements, characterization of the atmospheric transport properties of the valley, geothermal source characterization, and air quality modeling.

40676 Tritium tracer survey at the Geysers. Gulati, M.S.; Lipman, S.C.; Strobel, C.J. (Union Oil Co. of California, Santa Rosa). pp 237-239 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A tritium tracer survey was run in the Sulfur Bank No. 1 reinjection well in order to determine if any of the injected steam condensate is vaporizing and to determine how much of the injected water is being produced as steam at the nearby production wells. The reasons for running the tracer survey, the requirements for the tracer, the positive and negative aspects of tritium, and the information gained by using tritium are reviewed. (MHR)

40677 Potential environmental concerns associated with the development of geopressured-geothermal resources of the United States Gulf Coast. Gustavson, T.C.; McGraw, M.M. (Univ. of Texas, Austin). pp 245-248 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The commercial development of geothermal resources is described in terms of three location scenarios: production, generation, and disposal facilities are on coastal lowlands or uplands; these facilities on coastal marshlands or offshore production facilities and onshore generating and disposal. The ramifications and environmental impacts of these scenarios are explored. (MHR)

40678 Geological setting of reinjection wells in the Otake and the Hatchobaru Geothermal Field, Japan. Hayashi, M.; Mimura, T.; Yamasaki, T. (Kyushu Univ., Fukuoka City, Japan). pp 263-266 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The reinjection wells at Otake and Hatchobaru in Japan have been studied by geology and alteration mineralogy. At Otake, all reinjection wells met a fault plane at depths from 300 to 500 m, corresponding to the depth of the main production zone. The reinjection of 70°C water had the beneficial effect to increase the vapor output in some production wells, but a productive well near the fault was damaged. At Hatchobaru, both reinjection and production wells encountered at about 1,000 m deep the same unconformity which was the main reservoir. The reinjection more or less affected the cooling of all production wells. These facts suggest that the communication between the two kinds of well through those permeable zones should be avoided. In the case where both wells are drilled in the same formation (whose permeability is smaller than 2×10^{-3} cm/sec as in Otake), the minimum acceptable distance between reinjection and production wells will be 150 m, as an approximate standard. In conclusion, important factors concerning reinjection are summarized.

40679 Effects of corrosion and scale deposits on the capacity of water reinjection wells in liquid dominated geothermal systems. Jorda, R.M. (Completion Tech. Co., Houston, TX). pp 341-344 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Scale deposits or corrosion damage in water reinjection well tubing strings can result in reduction of reinjection capacity, thereby

limiting power recovery in liquid dominated geothermal systems. Simulation of a Texas Gulf Coast reinjection well under scaling and corrosive conditions indicates that either scale deposits or corrosion may require a tubing size of at least one nominal diameter larger than would be required if corrosion or scale deposition did not occur. This, in turn, would require the use of larger protective casing strings and bigger drilling bits.

40680 Air quality as the limiting factor on development of the Geysers geothermal resources. Joyce, L.; Fontes, R.A. (California Energy Commission, Sacramento). pp 345-349 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

An air quality problem exists at the Geysers California as a result of hydrogen sulfide (H_2S) emissions from geothermal power generation. The policy and legal issues engulfing the air quality problem and efforts to mitigate the problem are examined. Estimates are made of the air quality impacts of future generation capacity based on utility electricity supply plans as submitted to California Energy Commission (CEC). The status of current and developing H_2S abatement technologies is examined for availability and technical characteristics. Analysis is provided on the prospect and consequences of inadequate control of H_2S emissions. H_2S control efficiencies of less than 95 percent may ultimately be ineffective if full field development is to be achieved at The Geysers.

40681 Environmental necessity and sufficiency: the case of the Raft River project. Kunze, J.F.; Spencer, S.G. (EG and G Idaho, Inc., Idaho Falls). pp 391-393 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Long before it was drilled, the Raft River geothermal reservoir in southern Idaho was correctly characterized by geothermometry as a moderate-temperature resource. Three deep-hole wells have since been drilled into the Paleozoic quartz-monzanite basement, reaching the predicted 150°C (300°F) temperatures well before encountering the poorly-fractured basement. Described is the environmental program that began prior to drilling and accompanied the development of a complete well field for a 5-MW(e) [40-MW(th)] pilot plant.

40682 Removal of hydrogen sulfide from geothermal steam. Li, C.T.; Alzheimer, D.P.; Wilcox, W.A.; Roberts, G.L.; Riemath, W.F. (Battelle Pacific Northwest Labs., Richland, WA). pp 403-406 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Two processes studied for hydrogen sulfide removal from geothermal steam are: sorption (both physical and chemical) of H_2S by solid sorbents, and oxidation of H_2S in presence of oxygen and catalysts. It was concluded that the regeneration of zinc oxide and the carbonaceous polymeric sorbent is either technically too difficult or economically too expensive for practical application. A conceptual process design is shown for the catalytic oxidation process and its advantages and problems are listed. (MHR)

40683 Utilization of geothermal cooling waters for waste containment. Morrison, R.D. (SCS Engineers, Long Beach, CA). pp 469-470 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Geothermal power production utilizing a binary conversion process requires a substantial quantity of water for the cooling of the secondary or working fluid. Once this cooling water has left the condenser in such a system, it requires some form of process to lower its temperature. Several process alternatives are available: an evaporative dry cooling tower, a wet cooling tower, or a cooling lake. In those operations where a cooling lake is utilized or where large amounts of makeup water are stored, certain design parameters can be easily integrated into this cooling loop for the purpose of isolating geothermal or associated wastes. The necessary physical conditions and benefits of this arrangement are the subject of this paper.

40684 Preliminary environmental assessments of known geothermal resource areas in the United States. Phelps, P.L.; Ermak, D.L.; Anspaugh, L.R.; Jackson, C.D.; Miller, L.A. (Univ. of California, Livermore). pp 523-525 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The basic purpose of the Geothermal Overview Project is to identify, summarize, and assess the environmental issues of the top priority KGRAs from among the approximately 40 KGRAs currently identified by the Division of Geothermal Energy, DOE, as having high possibilities for commercial development. The Geothermal Overview Project addresses issues pertaining to air quality, ecosystems quality, noise effects, geological effects, water quality, socioeconomic effects and health effects. For each KGRA the following functions are accomplished: (1) identification of key issues, (2) inventory of all available data, (3) analysis and assessment of available data, and (4) identification of what additional information is required for adequate assessments. The complex study carried out for The Geysers - Calistoga KGRA in northern California is used as an example here.

40685 Microearthquake survey of the Radium Springs KGRA, south-central New Mexico. Quillin, B. (Microgeophysics Corp., Golden, CO); Combs, J. pp 547-550 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

For a nine-week period during September, October and November of 1975, seismicity was monitored in the area of Radium Springs Known Geothermal Resources Area (KGRA) located in south-central New Mexico in the Rio Grande Rift. The seismic array consisted of five, three-component seismograph stations with maximum station separation of less than 15 km. Two microearthquakes with coda-duration magnitudes of 0.0 were located and are apparently associated with surface mapped faults in the near proximity of the hot springs. By far the most abundant type of local seismic activity, hundreds of events per day, were nanoearthquakes of from 0.25 to 2.0 sec total duration corresponding to coda magnitudes of -3.2 to -1.1. These nanoearthquakes are caused by natural hydrofracturing associated with the local geothermal regime.

40686 Hawaii Geothermal Project: an aerometric study of mercury and sulfur emissions. Siegel, B.Z.; Siegel, S.M. (Univ. of Hawaii, Honolulu). pp 597-599 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Predrilling environmental baseline studies and extensive ongoing comparative aerometry in volcanic and rift areas have made it possible to characterize the University Experimental Geothermal Well (HGP-A) as a low-Hg, low H_2S emitter and to account for high levels of Hg in the environs of HGP-A in terms of natural events and processes in Kilauea and the East Rift.

40687 Geothermal development and wildlife behavior. Suter, G.W. II. (Oak Ridge National Lab., TN). pp 627-629 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Because of improved emissions control and tighter air and water quality regulations, disturbance of wildlife is replacing toxic emissions as the major ecological problem associated with hydrothermal development. This problem is discussed, using raptorial birds as an example. It is proposed that a 1 km buffer zone be observed around raptor nest sites in the arid, intermountain west. Suggestions are made for increased monitoring of wildlife behavior.

40688 Water Quality Management for Imperial Valley Geothermal Development. Swajian, A. (California Regional Water Quality Control Board, Palm Desert, CA); Morris, G.L.; Pimentel, K.D. pp 631-634 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A site-specific water sampling network was established in the Salton Sea Geothermal Field of Imperial Valley. Chemical analyses of representative water samples compiled from the network are summarized. A comparison of water sample constituents from the Salton Sea KGRA is given. The recommended chemical analyses of water samples are tabulated. (MHR)

40689 Development of injection criteria for geothermal resources. Tewhey, J.D.; Chan, M.A.; Kasameyer, P.W.; Owen, L.B. (Univ. of California, Livermore). pp 649-652 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The ability to inject large quantities of brine effluent will be an important factor in the development of liquid-dominated geothermal systems. Experimental studies have been conducted to evaluate injection of "spent" geothermal brine at the Salton Sea Geothermal Field (SSGF). The studies have dealt principally with the injectability of suspended solids that are produced in the brine during the energy conversion process. In the experimental plan, the subsurface medium was represented by membrane filters with pore diameters ranging from 0.4 to 10 microns and by sandstone core material. Changes in permeability with time were evaluated with respect to the following variables: (1) prefiltration of brine upstream from the core or membrane filter, (2) brine temperature (20 to 100°C), (3) brine pH (Owen, 1977), and (4) confining pressure.

40690 Practical hydrogen sulfide abatement process for air drilling and venting geothermal steam wells. Turner, T.A.; Rex, R.W. (Republic Geothermal, Inc., Santa Fe Springs, CA). pp 663-665 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A simple, economic process has been developed and applied to full-scale operations for the abatement of hydrogen sulfide emissions while air drilling and venting geothermal steam wells. The process consists of blooie line injection of sodium hydroxide and hydrogen peroxide. 91 to 98% of hydrogen sulfide emissions can be abated during the drilling of a typical geothermal steam well for a cost of less than $10,000.

40691 Ground water monitoring methodology for geothermal development. Weiss, R. (Harding-Lawson Associates, San Rafael, CA). pp 709-712 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The proposed groundwater monitoring methodology for geothermal development specifies a seven-step monitoring system development and evaluation procedure consisting of (1) definition of baseline conditions and projected development; (2) forecast of aquifer conditions; (3) definition of necessary detection limits; (4) evaluation of alternative groundwater and disposal facility monitoring techniques; (5) proposal of monitoring system and alternatives; (6) implementation of monitoring system; and (7) continuation of monitoring program and modification as necessary.

GEOTHERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 40667, 40683

40692 Comparative analysis of energy costing methodologies. Goldstein, S.; Trehan, R.; El-Sawy, A.; Leigh, J. (MITRE Corp., McLean, VA). pp 223-226 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

This is a comparative analysis of the methodologies used by 14 organizations active in various aspects of geothermal energy development to compute the levelized busbar costs of electricity from hydrothermal resources. Available busbar cost estimates reflect different interest and taxation rate, amortization periods, special allowances and other differences in assumptions and methodologies. The study focused on two major sources of differences: those related to different approaches to estimating engineering costs; and those arising from different assumptions and procedures in the financial models which convert engineering costs to busbar costs.

40693 GELCOM: a geothermal electric levelized cost model. Leigh, J.G.; Gupta, J.N. (MITRE Corp., McLean, VA). pp 399-402 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The model described is designed to project the costs of electricity generated from liquid-dominated hydrothermal geothermal resources. It exists in the form of an interactive computer program called GELCOM, written in FORTRAN IV. This paper provides an analytic explanation of the methodology.

DESIGN AND OPERATION

REFER ALSO TO CITATION(S) 40610

40694 (PNL—2926) Ahuachapan geothermal project: a technical and economic assessment. Bloomster, C.H.; DiPippo; Kuwada, J.T.; Russell, B.F. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1979. Contract EY-76-C-06-1830. 62p. Dep. NTIS, PC A04/MF A01.

Theeconomic and technical factors involved in using geothermal energy at Ahuachapan are examined. The experience at Ahuachapan is evaluated in relation to conditions prevailing in El Salvador and to conditions in the U.S. technical characteristics considered are: geological characteristics, well programs and gathering system, well productivity and geofluid characteristics, and energy conversion systems. Economic factors considered for El Salvador are: construction costs; environmental control costs; operating experience and costs; financing; taxes, subsidies, or incentives; marketing; and electrical system characteristics. (MHR)

40695 Determination of the 5 MW design case for power production at Raft River. Ingvarsson, I.J.; Madsen, W.W. (EG and G Idaho, Inc., Idaho Falls). pp 305-308 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

This paper documents a series of Rankine Cycle studies for power generation utilizing geothermal fluid as the heat source and isobutane as the working fluid. To find the plant configuration which would most effectively utilize the available energy, a parametric study was performed.The study considered the desirability of supercritical, single boiler or double boiler cycles, and the relative boiler temperatures and percentage isobutane flow split between the boilers in the double cycles for geothermal fluid temperatures of 260 to 360°F. This study was designed to discover thermodynamic trends which would point to an optimum isobutane cycle for geothermal fluid temperatures in this temperature range. The results of the parametric study were applied to derive a Nominal Design Case for a demonstration plant at Raft River, with a geothermal fluid resource at 290°F.

40696 Operational history of the geothermal loop experimental facility at the Salton Sea KGRA. Jacobson, W.O. (San Diego Gas and Electric Co., CA). pp 325-326 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The Geothermal Loop Experimental Facility at the Salton Sea KGRA was designed based on information and assumptions available in the early 1970's. Generally successful operation has enabled a detailed study of conversion cycles and risks associated with commercial geothermal power production at this resource to be completed. The study concluded that a two stage flash cycle is optimum for near term development rather than the original four stage flash/binary process. Principal remaining risks are related to the Salton Sea brines. Reliable production, handling and injection of these brines are expected to be demonstrated in future activity.

40697 Dynamic simulation of the Raft River geothermal electric plant and its supply system. Miller, J.D.; Snyder, R.W. (EG and G Idaho, Inc., Idaho Falls). pp 453-454 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Thermal and acoustic simulations of the Raft River binary cycle plant have been developed and used to develop controls and operating procedures and to define plant performance. The thermal-hydraulic simulation describes the behavior of the geothermal, isobutane and coolant loops during startup, shutdown and power range operation. A separate simulation has been used to study acoustic effects in the geothermal loop.

POWER PLANT SYSTEMS AND COMPONENTS

40698 (LBL—8645) Hydrocarbon heat transfer coefficients: preliminary isobutane results. Tleimat, B.W.; Laird, A.D.K.; Rie, H.; Hsu, I.C.; Seban, R.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Feb 1979. Contract W-7405-ENG-48. 30p. Dep. NTIS, PC A03/MF A01.

Research designed to obtain baseline heat transfer data on secondary fluid candidates for geothermal cycle systems is described. The apparatus was designed to provide baseline data under clean conditions to determine inside and outside heat transfer film coefficient, respectivly, for heating and condensation of secondary fluids being considered for binary systems. The secondary fluid loop simulates the binary cycle with steam, instead of geothermal fluid, as the heating fluid and a throttling valve instead of the turbine. Results on film coefficient for condensing the isobutane on the outside of a tube at various pressures and condensate loading, as well as prelimi-

nary results on flm coefficient for heating the isobutane inside a tube at 4.14 MPa (600 psia) and various flow rates, are presented. The isobutane was heated in a horizontal, type 316 stainless steel, instrumented tube by steam condensing on the outside. In the condenser, the isobutane was condensed on the outside of a horizontal tube, idential to that in the heater, by cooling water inside the tube. Each instrumented tube was fitted with a total of fifteen thermocouples imbedded in the wall of the tube at five stations located equally along the length of the tube. The inside and outside wall temperature of the tube at each of the five stations was calculated from the location of the imbedded thermocouples and their temperatures. The heat rate to the isobutane in the heater was determined by measuring the rate of condensing steam on the outside of the tube under eachof four sections by means of specially designed vapor-traced meters. The heat rate released by the condensing isobutane was also determined by measuring the rate of isobutane condensing on the outside of the tube with meters similar to those in the heater.

40699 Wellsite verification testing of an advanced geothermal primary heat exchanger (APEX). Addoms, J.F.; Breindel, B.; Gracey, C.M. (Aerojet Energy Conversion Co., Sacramento, CA). pp 1-4 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The wellsite test phase of a research program conducted by Aerojet Energy Conversion Company to establish the feasibility of using a recirculating solid bed material to eliminate heat exchanger fouling in geothermal service is described. Phase I of this program culminated in a laboratory demonstration of APEX concept feasibility with brine simulants. Testing under the current project phase of the research effort was conducted at the Geothermal Component Test Facility located at East Mesa, California. Technical feasibility was established by testing the effectiveness of the bed material in preventing the fouling of a heat exchanger test section. The elimination of fouling was demonstrated using both geothermal well water and facility cooling water as the fouling fluids.

40700 Liquid-fluidized-bed heat exchangers for a 50-MW plant. Allen, C.A.; Lawford, T.W.; Van Haaften, D.H. (Idaho National Engineering Lab., Idaho Falls). pp 5-8 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Liquid-fluidized-bed and conventional heat exchangers were sized for a 50-MW dual boiling plant for the Raft River resource. Thermal performance was calculated for low and high-pressure preheaters, low and high-pressure boilers, and condensers. A plant using liquid-fluidized-bed exchangers requires 56 percent of the heat-transfer surface area compared to a plant with conventional tube-and-shell exchangers. Shell volume is greater for fluidized-bed exchangers; however, increased shell cost is partially offset by the lower design pressure achieved by putting the geothermal fluid on the shell side. With the working fluid on the tube side, the isobutane inventory in the exchangers is reduced by 45 percent. Parasitic pumping costs due to pressure drops are the same for both systems within the accuracy of calculation.

40701 Geothermal rotary separator field tests. Cerini, D.J. (Biphase Energy Systems, Santa Monica, CA). pp 75-78 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The application of a two-phase rotary separator for geothermal energy conversion was demonstrated. Laboratory tests were conducted with clean water and steam at Biphase Energy Systems, Santa Monica, California. Field tests were conducted at a Union Oil Co., wellsite near Brawley, California. The system tested consisted of the major components of a total flow rotary separator/turbine conversion system. A nozzle converted the brine wellhead enthalpy to two-phase flow kinetic energy by impinging the nozzle flow tangentially on the inside of the separator. The flow was then subjected to the high centrifugal force field by the rotary separator. The liquid phase collected as a film on the separator drum with very little energy loss due to low relative velocities. The separated steam was allowed to flow radially inward to the central steam discharge. Potable water was obtained by condensing the steam. The brine collection system converted the liquid film kinetic energy to static pressure head. The system was operated for 117 hours in a high salinity environment. The system operated properly with no adverse effects from solids precipitation or scale buildup. The rotary separator produced separate flows of pure liquid and steam of greater than 99.5% quality.

40702 Cooling water requirements for geothermal power plants and water availability in the Imperial Valley. Goldsmith, M. (Jet Propulsion Lab., Pasadena, CA). pp 215-218 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The cooling water requirements for geothermal power plants are calculated as a function of reservoir temperature and power plant type, and the availability of cooling water in the Imperial Valley of California is examined. First consider the cooling requirements for flash steam plants. Approximately, the rejection load is proportional to the steam rate. The first step is to determine steam rates for plants using steam of various temperatures.

40703 Fossil fuel/geothermal hybrid cycle applied to marginally useful liquid dominated hydrothermal resources. Grijalva, R.L. (Pacific-Sierra Research Corp., Santa Monica, CA). pp 227-231 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Combining geothermal and fossil fuel energy into the so-called "hybrid" cycle is compared with a state-of-the-art double-flash geothermal power cycle using resources which vary from 312°F to 598°F. It is demonstrated that a hybrid plant can compete thermodynamically with the combined output from both a fossil-fired and a geothermal plant operating separately. Economic comparison of the hybrid and double-flash cycles is outlined, and results are presented that indicate the performance of marginal hydrothermal resources may be improved enough to compete with existing power cycles on a cost basis.

40704 Working fluid and cycle selection criteria for binary geothermal power plant. Ingvarsson, I.J.; Turner, S.E. (EG and G Idaho, Inc., Idaho Falls). pp 309-311 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Binary cycles using refrigerants as working fluids are an effective means of developing geothermal resources for power production. In order to maximize the utilization of the geothermal fluid resource over a temperature range of from 220 to 400°F (104 to 204°C), a study was performed to optimize a 50 MW plant design with respect to working fluid and thermodynamic cycle. Results indicate that, of the four fluids studied, propane is optimum for geothermal fluid temperatures of 200 to 280°F (93 to 138°C). For a temperature range of 300 to 360°F (149 to 182°C), isobutane performed best; and for temperatures of 380 to 400°F (193 to 204°C), pentane was most effective.

40705 Comparison of direct contact binary power plants for geothermal application using multiple cycles. Jacobs, H.R.; Cook, D.S.; Boehm, R.F. (Univ. of Utah, Salt Lake City). pp 321-323 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Direct contact systems with bottoming cycles for moderate temperature brines are shown to increase significantly the net power that may be produced per unit flowrate of brine. For 143.3°C brine pentane—hexane system yields the highest brine utilization.

40706 Binary cycle expander for geothermal power generation. Kennelly, J.R.; Geary, C.H. (Elliott Co., Jeannette, PA). pp 367-370 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A 50 megawatt hydrocarbon expander turbine was designed with an actual mechanical limit of approximately 80 MWe. The design pressures of 34 bar (500 psia) inlet and 13 bar (200 psia) exhaust were based on a mixture of iso-butane and iso-pentane. Inlet temperature is 149°C (300°F). The turbine is capable of being directly coupled to a two-pole 3600 r/s (3600 RPM) AC generator. The expander casing is a single body, vertically split barrel. Internal access and rotor removal are through the end opposite the drive end. The double flow rotor configuration has three expansion stages in each of the two flow paths. The flexible shaft design operates between the first and second critical speeds. Mechanical contact seals contain the hydrocarbon under all operating and shutdown conditions. The turbine design incorporates already developed components with operating experience.

40707 Heat transfer consideration in utilizing geothermal energy. Michel, J.W. (Oak Ridge National Lab., TN). pp 441-444 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Although some forms of geothermal energy will require the application of high temperature technology, most involve only low temperature. This paper emphasizes the importance of efficient, low cost heat exchangers in the use of low temperature sources and in the waste heat rejection systems of power generation cycles. Results of recent heat transfer development work at ORNL show that for the working fluids which are attractive for use in these cycles the condensation heat transfer effectiveness can be improved by a factor of from 3 to 7 by the use of fluted tubes and condensate drain-off skirts. Data are presented for condensation of six fluorocarbons, isobutane, and ammonia on a variety of tube surfaces. These results are being applied to the design of a 40-tube heat exchanger to be tested in a geothermal energy test facility.

40708 Turbine testing in direct contact binary loop. Nichols, K.E.; Lobach, J.L.; Hunt, J.W. (Barber-Nichols Engineering Co., Arvada, CO). pp 499-502 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The turbine power loop test program successfully demonstrated the production of electricity from a geothermal source using isobutane in a direct contact heat exchanger. The tests were completed at the East Mesa Component Test Facility utilizing brine from well Mesa 6-2. The turbo-generator unit consists of an axial flow, partial admission turbine, a gearbox, and a 60 KW 3600 rpm KATO generator. These components, along with controls and safety features, were mounted on a common skid. The turbine was calibrated on pure isobutane at subcritical and supercritical turbine inlet conditions. The IC_4 was heated using a conventional tube and shell heat exchanger. An endurance run of 500 hours was then completed using an existing direct contact heat exchanger loop designed and operated by DSS Engineers of Ft. Lauderdale, Florida. At the conclusion of this testing, the turbine, connecting pipes, and a portion of the direct contact heat exchanger were disassembled and inspected for evidence of scaling or erosion in the test hardware. The only scale deposition noted was in the turbine nozzles and blading. The remainder of the loop was in good condition and gave no evidence of distress which would prevent continued operation of the test loop. The scale formed on the nozzles and blading was shown to be primarily silicate by analysis. It was felt that liquid brine carryover was occurring. A demister component was added between the DCHX and the turbine and a subsequent 105 hour run showed insignificant scaling in the turbine.

40709 Control system for steam gathering at The Geysers. O'Daly, W.L. (Thermogenics, Inc., Culver City, CA); Morelli, G. pp 507-508 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Steam gathering and delivery to the new Pacific Gas and Electric Company (PG and E) Unit 15 at The Geysers will be controlled by an automatic computerized system. Total reservoir steam venting usually occurs because of unscheduled power plant outages. The requirement for the Thermogenics steam field specifies capability of reducing unabated steam venting by 60% within one hour. A simplified flow diagram shows the major components of the Thermogenics steam gathering system. The functions of the system are described. (MHR)

40710 Soil cooling for geothermal electric power plants in the Western United States: the Raft River experiment. Stanley, N.E.; Slegel, D.L.; Gertsch, W.D. (EG and G Idaho, Inc., Idaho Falls). pp 609-611 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

EG and G Idaho, Inc. is conducting a three-year experiment to study the technical and economic feasibility of using heat dissipation-soil warming systems to reject heat from modular-sized geothermal power plants in cool desert regions. The project focuses on two areas of study. First, a computer program is being developed to model the performance of soil cooling systems. Second, field studies are being conducted to evaluate the performance of an underground pipe system installed at the Raft River Geothermal Test Site in south-central Idaho. Direct extrapolation of the experimental field data to large-scale heat dissipation-soil warming systems would be difficult, at best. At Raft River, the approach taken is to use the experimental data to assess the accuracy of a computer program which models heat and mass transfer in soils. Given sufficient accuracy (or agreement between predictions and field data), the computer program would then be used to model proposed large-scale systems in order to assess their feasibility and potential benefits.

40711 Investigation of heat transfer coefficients of working fluids in geothermal power cycles. Tleimat, B.W.; Laird, A.D.K. (Univ. of California, Richmond). pp 655-657 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The objective of the binary fluid experiment described herein is to obtain data to determine baseline heat transfer data for working fluids being considered for binary cycle systems to produce power from hot geothermal brines. These data will be used to calculate film coefficients for heating, boiling, superheating, desuperheating as well as condensation for candidate working fluids.

GEOTHERMAL ENGINEERING

REFER ALSO TO CITATION(S) 40577

DRILLING TECHNOLOGY AND WELL HARDWARE

40712 (IDO—10077) INEL/Snake River plain geothermal drilling and testing plan - INEL - 1 well. Miller, L.G.; Prestwich, S.M.; Griffith, J.L. (Department of Energy, Idaho Falls, ID (USA). Idaho Operations Office). Dec 1978. Contract W-7405-ENG-82. 172p. Dep. NTIS, PC A08/MF A01.

A plan for drilling a 7500 ft exploratory hole is described. This hole would be drilled at the Idaho National Engineering Laboratory, so that it could be immediately used by one of the government facilties. The plan details the hole design, describes the drilling program, proposes a testing program, and estimates costs. (MHR)

40713 Geothermal drilling fluids systems. Bannerman, J.K.; Davis, N.; Wolke, R.M. (Dresser Industries, Inc., Houston, TX). pp 27-29 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Choice and control of the drilling fluid can determine the success of drilling a geothermal well. Generally, geothermal wells may be classified into two types: a vapor-dominated system which produces dry steam, or a hot-water system in which hot water flashes into steam near the surface due to reduced pressures. Although both systems are found in geothermal areas througout the world, the hot-water system is more prevalent. Prior to drilling into the production zones of both systems, the drilling-fluid types may be similar in nature. However, in drilling into a vapor-dominated (dry steam) system, the zone is normally drilled with air to avoid killing the producing zone by a hydrostatic column of fluid. A hot-water system is normally drilled to completion with conventional drilling fluids.

40714 Development of improved rotary seals for downhole motors in geothermal applications. Black, A.D.; Wilson, J.G.; Green, S.J.; Nixon, J.D. (Terra Tek, Inc., Salt Lake City, UT). pp 51-54 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The major limitation of downhole mud motors for geothermal well drilling as well as straight-hole oil and gas well drilling is the bearing section. Reduced bearing life has been a direct result of the inability to seal lubricant in the bearing section. Along with extending bearing life, a reliable rotary seal is needed to allow high pressure drops across the drill bit for improved bottomhole cleaning and increased drilling rate. A new approach to the development of an improved rotary seal is being carried out. The performance of candidate "high temperature" rotary seals compared with "standard" industry seals is being measured in a full-scale laboratory seal tester capable of simulating the temperatures, pressures and dynamic conditions of geothermal well drilling. A description of the candidate "high temperature" seals, the seal tester and current seal test results and findings are presented.

40715 Evaluation of cavitating jets for increased geothermal drilling rates. Conn, A.F. (Hydronautics, Inc., Laurel, MD); Radtke, R.P. pp 113-114 of Geothermal energy: a novelty becomes resource.

Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A program now underway has the ultimate objective of providing improved bit designs for deep-hole drilling, either for geothermal or fossil energy extraction. These bits would incorporate several CAVIJET cavitating fluid jet nozzles, in lieu of the conventional nozzles now sometimes used in such bits. Thus, in addition to providing the many tasks now required of the drilling mud, such as cleaning and cooling of the bit face and transporting the rock cutting to the surface, this new concept would exploit the destruction energy of cavitation induced in the mud to help break or weaken the rock.

40716 Development of geothermal well completion systems: I. Eilers, L.H. (Dowell Div. of the Dow Chemical Co., Tulsa, OK); Moran, L.K.; Nelson, E.B.; Spangle, L.B.; Simpson, B.E.; Williams, J.F. pp 173-175 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Cementing of geothermal wells requires special consideration because of unusual conditions of temperature, corrosive fluids, and fragile formations. Systems traditionally used in oil and gas well cementing may not function predictably in harsh geothermal environments thus leading to cement failure and costly blow-outs. The current research program consists of two phases: (1) definition of problem/determination of requirements and (2) development of a cementing system which will function effectively over long periods of time at the specified conditions. Phase I has been completed and preliminary Phase II results will be reported in this work. The results of a survey of various operators in the geothermal energy business are presented and compressive strength data on several lightweight cement systems currently under study are offered.

40717 Geothermal wellheads: the heart of geothermal production systems. Godare, B. (W-K-M Wellhead Systems, Inc., Shreveport, LA). pp 207-210 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The properly designed wellhead unit provides complete well control during the drilling, casing, cementing, well testing, and well production phases of a geothermal well's life. The geothermal wellhead unit must provide total well control at elevated temperatures. The wellhead must be designed to absorb varying amounts of production casing thermal expansion. Two basic geothermal wellhead completion techniques are shown. (MHR)

40718 Full-scale laboratory testing of experimental geothermal rock bits. Hendrickson, R.R.; Green, S.J.; Jones, A.H.; Winzenried, R.W. (Terra Tek, Inc., Salt Lake City , UT). pp 267-270 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Conventional rolling-cutter bits experience severe materials-related problems when used in many geothermal wells, since their materials have been optimized for lower temperatures. This program is designed to hasten the availability of improved geothermal drill bits by providing bit manufacturers with materials data. A preliminary study indicated severe drillability problems involving hard, abrasive formations at several KGRA's based on lithology, formation temperatures, mechanical rock properties, permeability, ultrasonically determined moduli, and mineral analysis obtained from Geysers, California; Imperial Valley, California; Milford, Utah; Baca Ranch, Valle Grande, New Mexico; Jemez Caldera, New Mexico; Raft River, Idaho; and Marysville, Montana. Wear measurements and metallurgical analysis of several failed bits revealed excessive gage wear and softening of the bearing surfaces. Modeling of wellbore temperatures helped to define the importance of circulating parameters, formation temperature, and reservoir conductivity in determining bit component temperatures. Materials properties tests were performed to provide data on the high-temperature capabilities of numerous candidate steels and carbides. Experimental 6-1/2 inch and 8-3/4 inch bits were built to evaluate materials performance in laboratory and field drilling tests; manufacturers consider such full-scale testing an essential augmentation to the physical properties data. The Geysers was the site considered in the selection of materials for the research bits since it typified the problematic hard-formation, air-drilled KGRA's, and because it provided extensive preliminary data, and a reliable field-test site.

40719 Casing design for high temperature geothermal wells. Karlsson, T. (Univ. of Iceland, Reykjavik). pp 355-358 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Experience from drilling in high temperature geothermal areas in Iceland indicates that temperatures and pressures to be expected on the well bottom may be assumed to follow the boiling curve based on the assumption of water at boiling conditions at any depth. This means that bottom temperature and pressure in a well of 2000 metres depth may be as high as 340°C and 145 bar respectively. At these conditions it may be difficult to design a string of casing based on the conventional requirements of keeping the casing material within the elastic limits. American design codes allow yielding under certain conditions. This can for example be found in the American Standards for pressure pipes as well as in the ASME Boiler and Pressure Vessel Code. Design procedures according to these two codes are similar and here, dealing with the design of casing, the ASME Code will be used as a reference.

40720 Improved geothermal drilling fluids. McDonald, W.J. (Maurer Engineering Inc., Houston, TX); Remont, L.J.; Carwile, C. pp 419-422 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The problems with drilling muds under geothermal conditions are outlined. A three phase approach to improve geothermal drilling includes: evaluation of commercially available geothermal muds, development of improved geothermal muds, and the application and utilization of improved geothermal drilling technology. Coal samples from various mines were the most promising materials tested, especially brown coal. (MHR)

40721 Drilling fluid formation damage in geothermal wells. Nicholson, R.W. (Republic Geothermal, Inc., Santa Fe Springs, CA). pp 503-505 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Matrix type hot water reservoirs are highly susceptible to near well bore permeability impairment due to drilling fluid filtrate and particle invasion. The drilling fluids must be properly formulated to allow an efficient drilling operation and yet neither interact with the formation and in situ fluids nor permanently plug the formation. Examination of the unique factors in matrix type geothermal reservoirs leads to steps which can be taken to alleviate formation damage problems during drilling.

40722 Case history: the completion of a shallow, over-pressured geothermal well. Rudisill, J.M. (Thermal Power Co., San Francisco, CA). pp 587-590 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A case history is presented of the drilling and completion of a shallow over-pressured geothermal well, Utah State 72-16, situated in the Roosevelt Geothermal Field, Beaver County, Utah. The problems encountered and the techniques used in completing this well are reported to assist other operators in safely drilling and completing in such shallow, over-pressured resources. The tasks of greatest difficulty were (1) the running of the 9-5/8" production casing and (2) remedying the consequence of an indicated imperfect cementing of the 13-3/8" surface casing. Patience, cooling of the well, and carefully performed and evaluated cement jobs were the techniques employed which contributed to the successful completion of these tasks.

40723 Geothermal well completions: state of the art. Snyder, R.E. (Completion Tech. Co., Houston, TX). pp 601-603 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Present methods for completing steam and liquid dominated, dry rock, and geopressured geothermal wells are described by interpretive review of actual and proposed operations in The Geysers, Imperial Valley, the Valles Caldera, New Mexico project, and Louisiana—Texas geopressured zones. Limitations of technology and equipment that have been adapted from the petroleum industry to meet new and unique requirements of these downhole environments are objectively analyzed.

40724 Progress in the water jet assisted drilling of rock. Summers, D.A. (Univ. of Missouri, Rolla); El-Saie, A.A. pp 623-626 of Geothermal energy: a novelty becomes resource. Transactions.

Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Evidence has shown that, at pressures currently available with commercial equipment, advance rates up to 200 ft/hr can be achieved in drilling granite. This rate is diminished by the application of the pressures to be found in a borehole at depths up to 6,000 ft. However, this reduction is to a much lesser extent in granite than in sandstone. It has also been shown to be advantageous to use abrasives and/or cavitation of the fluid flow in order to enhance drilling rates. At fluid pressures below 10,000 psi abrasive laden jets appear more effective, while at fluid pressure about 10,000 psi cavitating jets appear more effective.

40725 Mud solids control for minimum liquid discharge demonstrated on Wyoming Well: a possible application for geothermal drilling. Vesely, D. pp 687-688 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A 12,500 foot well was drilled in Wyoming with virtually no liquid discharge (jetting). This article explains how the solids control equipment was configured to achieve this objective and gives technical information regarding the percent solids removed by each piece of equipment.

CORROSION, SCALING, AND MATERIALS DEVELOPMENT

REFER ALSO TO CITATION(S) 40679, 40699

40726 (BNL—50979) Alternate materials of construction for geothermal applications. Progress report No. 17, October—December 1978. Steinberg, M.; Kukacka, L.E. (Brookhaven National Lab., Upton, NY (USA)). 1978. Contract EY-76-C-02-0016. 39p. Dep. NTIS, PC A03/MF A01.

A program to determine if non-metallic materials such as polymers, concrete polymer composites, and refractory cements can be utilized as materials of construction in geothermal processes is in progress. To date, several high temperature polymer concrete systems have been formulated, laboratory and field tests performed in brine, flashing brine, and steam at temperatures up to 260°C (500°F), and economic studies started. Laboratory data for exposure times > 2 years are available. Results are also available from field exposures of up to 24 months in four geothermal environments. Good durability is indicated. Work at five of these sites is continuing and plans to initiate other tests are being implemented.

40727 Field scaling tests on geothermal brines. Downs, W.F. (Idaho National Engineering Lab., Idaho Falls); Barnes, H.L.; Rimstidt, J.D. pp 165-166 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

An inexpensive field test was designed to determine scaling rates and compositions from homogeneous geothermal fluids. The technique used in these experiments is to abruptly cool the geothermal fluid to a controlled temperature. Brine flow was maintained at a set rate until sufficient scale had been precipitated to determine its composition and distribution along the flow path. Several series of experiments have been conducted using this design. The first two series of experiments were run at the U.S. Bureau of Mines Test Facility, Nyland, California. Brines from Magmamax 1 and Woolsey 1 (courtesy of the San Diego Gas and Electric Company) were individually passed through the heat exchanger.

40728 Important conclusions based on results of geothermal casing packer seal elastomers testing. Hirasuna, A.R.; Stephens, C.A.; Veal, G.R. (L'Garde, Inc., Newport Beach, CA). pp 279-282 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Development of casing packer seal elastomers was initiated in late 1976. Special evaluation tests were designed and fabricated to simulate the unusually severe environment and to evaluate critical characteristics. Testing to date indicates fundamental deficiencies will exist with current day packer systems operating at higher geothermal temperatures. The casing packer seal element was selected as the target application and the associated duty cycle defined was 260°C (500°F) for 24 hours, 4000 psi differential pressure, and the following chemistry: H_2S 300 ppM, CO_2 1000 ppM, NaCl 25,000 ppM, and the balance water. These conditions have been simulated in the laboratory and have proven to be unusually severe as regards the elastomer compounds tested to date. The test methods, the resulting data, and the conclusions drawn from the resulting data are discussed.

40729 Corrosion testing in a multiple-stage flash system. McCright, R.D.; Garrison, R.E.; Locke, F.E. (Univ. of California, Livermore). pp 415-417 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Corrosion rate results from a 720-hour exposure period to geothermal brine acidified to pH[4] are discussed. The corrosion tests were performed in a four-stage flash system so that results obtained at different temperatures could be compared. Carbon steel and alternate construction materials were used as test specimens. Results indicate that carbon steel corrodes excessively (more than 50 mils/year) at temperatures above 150°C. Alternate construction materials (alloy steels) may be utilized under these conditions.

40730 Results of short-term corrosion evaluation tests at Raft River. Miller, R.L. (Idaho National Engineering Lab., Idaho Falls). pp 461-463 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Four categories of short-term materials evaluations tests were conducted in geothermal fluid fron well No. 1 of the Raft River Geothermal Experiment to obtain corrosion data relevant to the design of the Raft River Pilot Power Plant. The test programs are described and testing philosophies are discussed. The results of the tests are described and conclusions and recommendations are made for each type of material.

40731 Experiments for rapid assessment of the scaling properties of geothermal fluids. Rimstidt, J.D.; Barnes, H.L. (Pennsylvania State Univ., University Park). pp 567-569 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Even though scaling is a major problem in many geothermal heat extraction systems, too often such systems are designed with only minimal regard for scale prevention. However, there are some simple thermodynamic and kinetics principles that can be utilized in the basic design of these systems. In addition, it is useful to perform simple field tests on the geothermal fluid to determine its scaling characteristics under conditions similar to those expected in the heat extraction facility. Two simple experimental methods have been designed which can be used at low cost to empirically test scaling behavior prior to the installation of expensive pilot or power plants. These experiments and related kinetic factors are considered here.

40732 Geothermal fluid investigations at Republic's East Mesa test site. Vetter, O.J. (Vetter Research, Costa Mesa, CA); Campbell, D.A.; Walker, M.J. pp 689-692 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Some of the experiments and tests performed thus far in the northern part of the East Mesa Geothermal Field are summarized. The investigations described concern only the fluid characteristics pertinent to future power plant design and operation. Test facilities including test loops, fluid composition, scaling tendencies, pH control experiments and gas behavior ("noncondensables") are briefly reviewed. The data available thus far indicate that the geothermal fluids will present no significant technical problems in a conventional flashed steam power cycle.

GEOTHERMAL RESERVOIR AND WELL PERFORMANCE

REFER ALSO TO CITATION(S) 40589

40733 (HCP/T2259—05) Existence and flow behavior of gas at low saturation in geopressured formations. Final report. Matthews, C.S. (Department of Energy, Washington, DC (USA). Div. of Geothermal Energy). Apr 1979. Contract EW-78-X-05-2259. 62p. Dep. NTIS, PC A04/MF A01.

The first geopressured brine well tested for the Department of Energy produced gas and brine at a ratio far above the solution ratio for the gas in that brine. One explanation advanced was that the geopressured formation contained gas at a low saturation, and that this gas flowed into the well during the test. This hypothesis is examined and found to be untenable based on evidence from well logs, flow tests and thermodynamics, and on currently accepted concepts for migration and accumulation of petroleum. The probable

explanation for the observed high gas/water ratios is shown to be a thin, tight gas-bearing layer in the case of one sand and an updip gas cap in the case of the second and tested.

40734 Introduction to the geothermal well design handbook. Butz, J.R. (Denver Research Inst., CO); Coury, G.E. pp 59-62 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A handbook has been developed which enables the user to predict wellhead fluid pressure, temperature and quality (steam fraction) for geothermal wells in two-phase flow, when certain reservoir parameters are supplied. The procedure requires only a pocket electronic calculator and a series of graphs which are presented in the handbook. Input parameters may be changed so that the influence of such variables on the wellhead conditions can be determined through graphs of results or other numerical techniques. Several simplifying assumptions were made to permit the present treatment. The graphs included show water properties as they change with temperature, and two-phase pressure drop as a function of well depth (for a discrete set of input parameters). The user is led through the procedure by the handbook's Well Design Data Sheet.

40735 Analysis of geothermal well pumping. Campbell, T.A. (Republic Geothermal, Inc., Santa Fe Springs, CA). pp 63-66 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A system study of geothermal well pumping includes the evaluation of the problems of how to determine the net power output of pumped wells for various productivity indices. The principal parameters needed are presented and the present value income of two common well casing programs is compared.

40736 Well test results from HGP-A. Chen, B.H.; Kihara, D.H.; Yuen, P.C.; Takahashi, P.K. (Univ. of Hawaii, Honolulu). pp 99-102 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

After five flash discharge tests with the longest duration of 42 days, HGP-A appears to be capable of producing two-phase fluid over a range of wellhead pressures from 50 to 237 psig where the steam quality varies from 64 to 52%. The Kapoho Geothermal Reservoir appears to be a liquid-dominated formation with temperature measured as high as 358°C. The formation seems to be tight with possible severe mud damage in the well. The fluid produced is surprisingly clean containing about 5% ocean water but with fairly high silica content.

40737 Testing and modeling of downhole heat exchangers in shallow geothermal systems. Culver, G.G. (Oregon Inst. of Tech., Klamath Falls); Reistad, G.M. pp 129-131 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

At the present time, over 400 downhole heat exchangers are being used in relatively shallow wells for extraction of geothermal energy at Klamath Falls, OR. Despite the large number of installations, the exact nature of the flows and hence the optimal heat exchanger designs have not been determined. The results are reported of work on (1) characterizing flows in wells with perforated casings (as in Figure 1) with and without DHEs installed, (2) determining energy extraction rates for conventinal DHEs in both cased and uncased wells, and (3) modeling of DHE systems to predict effects of heat exchanger and well variable changes.

40738 Pressure transient analysis for two-phase geothermal reservoirs. Garg, S.K. (Systems, Science and Software, La Jolla, CA). pp 203-206 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A major concern of well-testing is the interpretation of pressure transient data. There is, in general, a lack of a methodology for the analysis of nonisothermal reservoir systems, either single or two-phase (liquid water/steam). Geothermal reservoirs commonly involve nonisothermal two-phase (water/steam) flow during well-testing. A theoretical framework for analyzing multiphase pressure transient data in geothermal systems is presented. A fully penetrating well located in an infinite reservoir of thickness h is considered. Any variations in either formation or fluid properties in the vertical direction are neglected (this is a common assumption in pressure transient analysis). The geothermal system may either be two-phase prior to production, or may evolve into a two-phase system as a result of fluid production. In the latter case, a boiling front will propagate outwards from the wellbore. The boiling front may be treated as a constant pressure boundary (p = saturation pressure corresponding to the local reservoir temperature).

40739 Predicting production temperature using tracer methods. Hanson, J.M.; Kasameyer, P.W. (Univ. of California, Livermore). pp 257-258 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Estimates of the thermal history of reinjected fluid are necessary to insure that power production and plant equipment performance can be maintained for the design lifetime of the heat recovery system. Uncertainty in the knowledge of the flow geometry may lead to significant error in the projected production temperature. Using a simple reservoir model, it can be shown that the length of time required for an injected fluid element to heat to a given temperature is independent of the streamline path taken by the fluid element. This rather general statement suggests that a knowledge of the distribution of fluid residence time between injection and production wells is sufficient to estimate the production temperature history for reservoirs for which the model is applicable. The distribution of fluid residence time can be obtained using tracer standard methods. A general expression for the production temperature is obtained based on this observation and the assumption that the porosity-thickness product phi h, is known or can be estimated.

40740 Reservoir engineering study of a portion of the Salton Sea Geothermal Field. Morse, J.G.; Thorson, L.D. (Univ. of California, Livermore). pp 471-474 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A well testing program is being conducted in the Salton Sea Geothermal Field in the vicinity of the Geothermal Loop Experimental Facility. Six well tests have been conducted as of January 15, 1978. Equipment has been developed and modified for use in the corrosive hot temperature brine environment. A computer program using superposition of analytic solutions is being developed to assist in analyzing the data. Initial results indicate that the reservoir has horizontal permeabilities of 100 to 500 md while vertical permeabilities across the shale layers are from 0.1 to 1.0 md.

40741 Hand computer program for James' Lip pressure steam flowrate. Ramey, H.J. Jr. (Stanford Univ., CA). pp 555-557 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

An important geothermal fluid production problem is measuring the flowrates from wells in liquid-dominated steam reservoirs. One such method is the James' Lip Pressure method. A hand computer program capable of making the necessary computations is presented. This program is written in reverse Polish logic for the HP-67/97 hand computers. The program description including equations is given.

40742 Salton Sea geothermal reservoir simulations. Riney, T.D.; Pritchett, J.W.; Garg, S.K. (Systems, Science and Software, La Jolla, CA). pp 571-574 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The Salton Sea Geothermal Field (SSGF) is a high salinity, high-temperature resource. The San Diego Gas and Electric Company has constructed a nominal 10 MWe Geothermal Loop Experimental Facility (GLEF) which will use brine produced from Magma Power Company's Woolsey No. 1 (W1) and Magmamax No. 1(M1) wells; the Magmamax No. 2 and No. 3 (M3) wells will be used for reinjection. Intermittent brine production/injection has been performed since May 1976, but no associated fluid flow data have been published. The Lawrence Livermore Laboratory (LLL), however, has correlated the data available from surface measurements and logs from various wells in the SSGF. This limited data base and the MUSHRM simulator were used to synthesize a preproduction reservoir model for a portion of the SSGF which contains the GLEF site. The simulator is then applied to the model to examine reservoir performance under different assumptions to improve our understanding of the system and its potential for exploitation.

40743 Application of type curve procedures for the analysis of production data from geothermal wells. Rivera-R., J. (Comision Federal de Electricidad, Mexico City, Mexico). pp 575-578 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

It has been shown that the decline-curve analysis approach can be successfully applied to geothermal wells. It was shown in Reference 1 that by plotting monthly production vs time on either semilog or log—log paper together with the rate decline models given by Arps, it was possible to predict the future production of wells of the Cerro Prieto Geothermal Field. It is shown that production forecasting can also be performed by an entirely graphical procedure. The procedure is based on the use of a basic dimensionless graph which was developed by Fetrovich. He found that rate decline models developed by Arps could be placed on a single log—log type curve. The aim of this paper is to show how this graph was used to handle production data from some wells of the Cerro Prieto Geothermal Field. The results obtained from the graphical procedure agreed with those obtained from that procedure previously.

40744 Pumping experience in geothermal wells at East Mesa. Verity, R.V.; Fisher, C.E. (Republic Geothermal, Inc., Santa Fe Springs, CA). pp 683-685 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Republic Geothermal, Inc. is presently carrying out extensive well testing in the East Mesa Field. The testing and development of geothermal well pumps is one important phase of this testing. The intent is two-fold: (1) to test the deliverability of the wells under high rate pumping conditions and (2) to guide the economic selection of well pumps for production to the future power plant. To date, two types of pumps have been tested, a lineshaft turbine pump and an electric submersible pump.

SAFETY AND CONTROL

REFER ALSO TO CITATION(S) 41621

RESERVOIR STIMULATION AND EXTRACTION TECHNOLOGY

40745 (LA—7771-MS) Hot dry rock energy extraction field test: 75 days of operation of a prototype reservoir at Fenton Hill, Segment 2 of Phase I. Tester, J.W.; Albright, J.N. (eds.). (Los Alamos Scientific Lab., NM (USA)). Apr 1979. Contract W-7405-ENG-36. 107p. Dep. NTIS, PC A06/MF A01.

Results from the first extensive field test of a man-made hot dry rock (HDR) geothermal reservoir in low permeability crystalline rock are presented. A reservoir with a small heat transfer area was utilized to study the characteristics of a prototype HDR system over a shortened lifetime. The resulting accelerated thermal drawdown was modeled to yield an effective area of 8000 m^2. In addition to the thermal effects, this test provided an opportunity to examine equipment operation, water permeation into the formation, geochemical interaction between the circulating fluid and the rock and flow characteristics including impedance and residence time distributions. Continuous monitoring for induced seismic effects showed that no activity to a Richter threshold of -1.0 was detected during the 75-day experiment.

40746 (LA-UR—79-679) Energy extraction operations: some preliminary results. Hendron, R.H. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 10p. (CONF-790615—10). Dep. NTIS, PC A02/MF A01.

From 3. US national congress on pressure vessels and piping; San Francisco, CA, USA (25 Jun 1979).

An experimental project being conducted by the Los Alamos Scientific Laboratory (LASL) has extracted thermal energy from Precambrian granitic rock by injection and circulating water through fractured zones or reservoirs. Two boreholes were drilled to depths of about 3 km (10,000 ft) in a location selected for high heat flow and an apparent lack of faulting. Bottom-hole temperature was 205°C (400°F). The holes were connected at depth by hydraulic fracturing to form a flow path and heat extraction surface. Energy has been extracted at rates exceeding 5 MW(t) in three operations totaling 2847 h. These operations are summarized.

40747 Engineering methods for predicting productivity and longevity of hot-dry-rock geothermal reservoir in the presence of thermal cracks. Hsu, Y.C.; Lu, Y.M.; Ju, F.D.; Dhingra, K.C. (Univ. of New Mexico, Albuquerque). pp 297-298 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Additional heat extraction from geothermal energy reservoirs depends on the feasibility to extend the main, hydraulic fracture through secondary thermal cracks of the adjacent hot rock. When the main fracture is cooled sufficiently, secondary thermal cracks are produced normal to the main fracture surface. As such, both the heat transfer surface area and heat energy available to the fluid circulating through the main fracture system increase. The objectives of this investigation are: (1) to study how the main, hydraulic fracture can be extended through secondary thermal cracks of the rock and (2) to develop methods for predicting the productivity and longevity of a geothermal reservoir.

40748 Energy extraction experiments in the SGP reservoir model. Hunsbedt, A.; Kruger, P. (Stanford Univ., CA). pp 299-301 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Studies of heat extraction efficiencies from fracture-stimulated and low-productivity hydrothermal resources, which will aid in the rapid growth of geothermal energy utilization, are an ongoing part of the Stanford Geothermal Program. Recent experiments have been run to compare both specific energy extractions and energy extraction fractions from a sand-packed rock loading with lower porosity and permeability to these values in the original high porosity, high permeability rock loadings. The data are useful in extrapolating the reservoir model results to large-scale geothermal reservoirs. The results for two experiments produced by the in-place boiling process show improved energy recovery with insignificant impedance of natural convection and cooling of the rock.

40749 Improved method of flashing and shocking geothermal wells. Johnson, W. (Nitrogen Oil Well Service Co., Houston, TX). pp 337-339 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A quick and effective method to initially flash and/or shock a geothermal well utilizing a coiled tubing unit and nitrogen gas is described. Most of the geothermal wells in the Imperial Valley need a catalyst for initial flashing. The completion mud may be displaced with fresh water and with time the water will gain enough heat to flash. Solid carbon dioxide, or dry ice, is sometimes placed into the well where it gains heat and converts to a gas. The carbon dioxide gas provides enough additional energy to initiate flow. A quicker and more positive approach to initiate flow is accomplished by displacing the wellbore fluids utilizing nitrogen gas circulated through 1" O.D. coiled tubing.

40750 Enhanced recovery reservoir engineering aspects of geothermal development. Miller, R.J. pp 457-459 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The recovery of heat resources is the primary purpose of geothermal development. The production of primary reservoir fluids however, may recover only a very small percentage of reservoir heat. The adoption of effective enhanced recovery methods will be necessary if efficient use is to be made of existing geothermal resources. This summary paper outlines the reservoir engineering aspects of both primary fluid recovery and enhanced recovery methods.

40751 Single-hole concept of heat extraction from hot dry rock masses. Ratigan, J.L. (RE/SPEC Inc., Rapid City, SD); Lindblom, U.E. pp 559-562 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The feasibility of the single drillhole concept of geothermal energy extraction can be examined in two manners, viz: (a) the full scale concept can be constructed in the regions of expected high productivity or (b) numerical modeling techniques can be developed and validated for modeling the concept, examining feasibility, and optimizing the engineering design aspects of the system. Here, the modeling efforts which have been undertaken to analyze the single drillhole concept and future plans for validation of the numerical techniques are described.

40752 Magma as a geothermal resource: a summary. Stoller, H.M.; Colp, J.L. (Sandia Labs., Albuquerque, NM). pp 613-615 of Geothermal energy: a novelty becomes resource. Transactions.

Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The following aspects of the Magma Energy Research Project are reviewed: source location and definition, source tapping, magma property and material compatibility, and energy extraction. (MHR)

40753 Well penetration and stimulation. Williams, R.E. (Denver Research Inst., CO). pp 729-730 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Two aspects of explosive fracturing - depth of penetration and degree of fracturing were investigated. A study was made of penetrators employing designs other than typical conical shaped charges. Configurations included linear, hemispherical and "dished" designed shaped charges. Through the mechanism of wave shaping as a technique for shock enhancement, fracturing of a host rock was investigated. These two elements, depth of penetration and degree of fracturing, were used as criteria for the design of a single package which generally consists of simultaneously initiated perforators closely followed by a main driver charge(s) which is (are) wave-shaped to cause fracturing in a rock media. The device was successfully field tested in five marginal oil wells and indicates an applicability to geothermal stimulation.

DIRECT ENERGY UTILIZATION

REFER ALSO TO CITATION(S) 40577, 40669, 40737

40754 Geothermal development in Reno. Atkinson, D.J. pp 21-23 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Past direct geothermal utilization, the nature of the geothermal resource, and the possibilities for future geothermal use in Reno, Nevada, are explored. The need for careful large-scale planning is emphasized. (MHR)

40755 Low temperature geothermal space heating demonstration project. Austin, J.C. (CH2M Hill, Inc., Boise, ID). pp 23-26 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A demonstration project for the State of Idaho utilizes 170°F geothermal water from well sources established in 1892. The project is a retrofitted gas-fired system serving three buildings. Two separate water loops are interfaced through a primary heat exchanger. The geothermal loop is capable of delivering up to 400 gpm at 166°F to the exchanger which transfers about eight million Btu/h to the space heating loop. The spent geothermal water is cooled and aerated, then discharged to the Boise River. The second loop is a closed system including the existing boiler, pumps, and piping retrofitted to the new heat exchanger. In addition to demonstrating the technology to utilize low temperature sources for space heating, the project examines economic feasibility, environmental impacts, and materials effects.

40756 Potential for geothermal desalination in New Mexico. Chaturvedi, L.; Keyes, C.G. Jr.; Swanberg, C.A.; Gupta, Y.P. (New Mexico State Univ., Las Cruces). pp 91-94 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The state of New Mexico contains eight KGRAs and many other locations where hot water has been encountered in hot springs and wells. The location of major geothermal areas in New Mexico is shown. Much of the geothermal resource in New Mexico occurs as hot water with high amount of total dissolved solids. Also, there are high salinity aquifers in the vicinity of geothermal areas. The occurrence of thermal saline water in New Mexico is shown. Since New Mexico is an arid area with continuously increasing demand for new sources of water for agriculture, industry, mining and municipal use, desalination of the state's saline water has often been regarded as a possible source of future water supply. Unfortunately, the present technology of desalination does not economically compete with the available supply of fresh water. Desalination of geothermal water or desalination of cold groundwater using geothermal energy, therefore appears to be an interesting alternative.

40757 Geothermal: a viable and economic comfort heating system choice. Donovan, L.E. (Idaho National Engineering Lab., Idaho Falls). pp 163-164 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The energy problem and the advantages and costs of geothermal heating are discussed. Costs for components of representative forced air and hydronic residential heating systems, both conventional and geothermal, were estimated. (MHR)

40758 Total energy recovery system for agribusiness: Lake County study. Fisher, L.A.; Black, A.R.; Fogleman, S.F. (International Engineering Co., Inc., San Francisco, CA). pp 193-194 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

International Engineering Company, Inc. (IECO) has reviewed, modified, adapted, and updated the conceptual design of its initial study on the Total Energy Recovery System for Agribusiness (TERSA) to be suitable for a specific site or area in Lake County, California. The objective of the initial study was to evaluate the costs and viability of combined thermodynamic and biologic cycles in a system known as TERSA. This conceptual system involved the combined geothermally heated activities of greenhouse crop and mushroom growing, fish farming, and biogas generation in an integrated biologic system such that the waste or by-products of each subsystem cycle were recovered to service input needs of companion cycles.

40759 Geothermal field near New Mexico State University and its potential as campus energy supplier. Gunaji, N.N.; Chaturvedi, L.; Thode, E.; LaFrance, L.; Swanberg, C.; Walvekar, A. (New Mexico State Univ., Las Cruces). pp 241-244 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A geothermal field exists near New Mexico State University campus at Las Cruces, New Mexico. The field is situated about two miles from the main campus, partly on University land and partly on adjacent state and private land. Geological, geophysical, geochemical and drilled wells information all indicates the existence of a geothermal aquifer, several square miles in area, perhaps 300 to 400 ft in thickness, containing water at 60 to 100°C with about 2000 to 2500 ppM dissolved solids at a depth of 600 to 2000 ft. Conceptual engineering designs and technical-economic analysis reveal several financially attractive campus applications which should be feasible with "off-the-shelf" technology. These applications include hot water supply and space heating on campus.

40760 Economics of the heat pump as a device to assist in geothermal district space heating. Kunze, J.F.; Forsgren, K.F. (Forsgren, Perkins and Associates, Rexburg, ID). pp 387-390 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The heat pump analysis considers source water of four temperatures: 55°F, 80°F, 130°F, and 180°F. To evaluate the economics of these four resources, two different climates were compared. The first is an 8400°F-day situation with an ASHRAE design temperature of -11°F, corresponding to cities with a climate similar to Idaho Falls. The second situation is 5600°F-day with an ASHRAE design temperature of +3°F, corresponding to the climate in Boise, Idaho. For the cases given, a district system of homes and businesses was chosen equivalent to 7500 average homes or 20,000 population. (MHR)

40761 Economic feasibility model for direct heat applications of geothermal energy. Larson, T.C. (Science Applications, Inc., La Jolla, CA). pp 395-398 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

An Economic Feasibility Model (GEYSER) to determine the viability of direct heat applications of geothermal energy is described. The Price of the Product or the Return on Investment can be determined given the required economic parameters. Variables can be adjusted to perform sensitivity analysis, the key economic

variables can be highlighted, and the range of profitability can be forecasted.

40762 Fluidized bed low-temperature geothermal drying. Schmitt, R.C. (Idaho National Engineering Lab., Idaho Falls); Cole, L.T.; Oates, J.H. pp 591-592 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A series of low-temperature geothermal drying experiments at the Raft River Geothermal Site are in progress. This paper will delineate the results from the initial test work, particularly as it pertains to the use of geothermal heat in drying operations on waste materials from potato processing operations.

40763 Westen States Cooperative Direct Heat Geothermal Program of DOE. Wright, P.M. (Univ. of Utah Research Inst., Salt Lake City); Foley, D.; Nichols, C.R.; Grim, P.J. pp 739-741 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The objectives and scope of the program are reviewed. The present knowledge of low temperature geothermal resources is discussed. Results from Phase I of this program are mentioned. (MHR)

GEOTHERMAL DATA AND THEORY

REFER ALSO TO CITATION(S) 40636, 40643

40764 CO_2 in geothermal steam: a rapid, precise, and accurate field assay technique. Michels, D.E. (Republic Geothermal, Inc., Santa Fe Springs, CA). pp 445-448 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

A system for sampling and measuring noncondensable gases in steam has been devised for field use, giving results for CO_2 and non-CO_2 fractions as weight percent in steam. Six to eight determinations can be made per hour with a precision better than +-0.04 of the measured value, providing a way to examine short-period patterns in gas contents as well as finding concentrations needed for engineering design. In this assay-type method condensate and noncondensables are collected together in a calibrated syringe at a precisely measured pressure and at ice water temperature. Henry's law is applied to compute the portion of the total gas which is dissolved in the condensate. Hardware is designed around 1/8" O.D. stainless steel tubing which solves in a simple way sampling problems that otherwise tend to give serious inaccuracies. Several additional advantages flowing from the use of small-diameter tubing make the system especially serviceable in the field.

PROPERTIES OF AQUEOUS SOLUTIONS

40765 Viscosity of geothermal brines. Potter, R.W. II. (Geological Survey, Menlo Park, CA). pp 543-544 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

One of the prerequisites of modeling the flow of fluid in a geothermal reservoir is knowledge of the viscosity of the fluid involved. Due to a general paucity of viscosity data for high-temperature brines, the general practice outside the petroleum industry has been to use some empirical correlation of the viscosity of pure water other than those formulated for the steam tables. Some alternative methods to model the viscosity of brines are suggested and a model is described which allows the limited data for brines to be extrapolated to conditions of interest in a geothermal reservoir.

PROPERTIES OF MINERALS AND ROCKS

REFER ALSO TO CITATION(S) 40591, 40607

40766 Thermal conductivity of crystalline rocks associated with energy extraction from hot dry rock geothermal systems. Sibbitt, W.L.; Dodson, J.G.; Tester, J.W. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *J. Geophys. Res.;* **84**: No. B3, 1117-1124(10 Mar 1979).

Because the lifetime of and heat extraction rate from a hot dry rock (HDR) geothermal reservoir can be substantially controlled by the in situ rock thermal conductivity, information concerning the dependence of thermal conductivity on moisture content and temperature is important for proper design and management of the reservoir. Results of thermal conductivity measurements are given for 14 drill core rock samples taken from two exploratory HDR geothermal wellbores (maximum depth of 2929 m (9608 ft) drilled into Precambrian granitic rock in the Jemez Mountains of northern New Mexico. These samples have been petrographically characterized and in general represent fresh competent Precambrian material of deep origin. Thermal conductivities, modal analyses, and densities are given for all core samples studied under dry and wet ('water-saturated') conditions. A cut bar thermal conductivity comparator and a transient needle probe were used for the determinations with fused quartz and Pyroceram 9606 as the stardards. The maximum temperature range of the measurements was from the ice point to 250°C. The measurements on wet rock were limited to the temperature range below room temperature. Conductivity values of the dense core rock samples were generally within the range from 2 to 2.9 W/mK at 200°C. Excellent agreement was achieved between these laboratory measurements of thermal conductivity and those obtained by in situ measurements run in the HDR wellbores. By using samples of sufficient thickness to provide a statistically representative heat flow path, no difference between conductivity values and their temperature coefficients for orthogonal directions was observed. This isotropic behavior was even found for highly foliated gneissic specimens. Estimates of thermal conductivity based on a dispersion and/or mixture analysis utilizing pure minerallic phase conductivities and detailed modal analyses usually agreed to within 9% of the experimental values.

40767 Experimental steam—water relative permeability curves. Chen, H.K. (Phillips Petroleum Co., Bartlesville, OK); Counsil, J.R.; Ramey, H.J. Jr. pp 103-104 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, California; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Steam and water relative permeabilities have been determined at various liquid water saturations using bench-scale model flow data. Relative permeability data are important because it may be used to forecast the mass and energy recovery from geothermal reservoirs.

40768 Effect of temperature level on absolute permeability of unconsolidated silica and stainless steel. Danesh, A. (Abadan Inst. of Tech., Iran); Ehlig-Economides, C.; Ramey, H.J. Jr. pp 137-139 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Several experimental studies have demonstrated temperature effects on absolute permeability. Recent studies have indicated that the magnitude and direction of the permeability changes in response to changes in temperature may vary, depending upon the flowing fluid and the porous medium. A brief discussion of the pertinent theoretical concepts is presented here. Then, the results of several experiments designed to isolate certain parameters that the theory suggests to be relevant are given.

40769 Inspection of experimental data on vapor pressure lowering in porous media. Hsieh, C.H.; Ramey, H.J. Jr. (Stanford Univ., CA). pp 295-296 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The effect of capillarity on vapor pressure lowering in porous media was discussed by Calhoun et al (1949) in a classic study. Experimental data were presented on the relative pressure ratio for several sandstone cores, and the data were interpreted in terms of capillary effects caused by curved liquid interfaces within porous media. This study indicates that the relative pressure ratios were more likely caused by adsorption.

40770 Dependence of velocity and resistivity of volcanic rocks on temperature and porosity. Ibrahim, A. (Colorado School of Mines, Golden). pp 303-304 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 1. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Laboratory measured P-wave seismic velocities and resistivities of water saturated Cenozoic volcanic rocks show a dependence on porosity, saturation, and texture. Seismic P-wave velocities decrease with increase in porosity, but appear to be unaffected by temperature changes between 25°C and 110°C. They also change with changes in water saturation. At high saturation (100 to 85%) velocity decreases with increase in saturation. At low saturation this trend is reversed. Electric resistivities decrease with the increase in

temperature below the boiling point, and rapidly increase above this point. It decreases with increase in water saturation. In most cases, samples showing anomalous seismic velocities have anomalous resistivities.

40771 Characterization of crack structure controlling permeability using velocity-pressure data. Warren, N. (Univ. of California, Los Angeles). pp 701-702 of Geothermal energy: a novelty becomes resource. Transactions. Volume 2, Section 2. Davis, CA; Geothermal Resources Council (1978).

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

Expressions for permeability and elastic moduli are derived. Such expressions provide a means of modeling the microstructure controlling permeability and velocity and they elucidate the feasibility of predicating the functional dependence of permeability on pressure from independent determination of microstructure, such as from ultrasonic data. Two conclusions that can be drawn are: (1) that various pressure laws are equally admissible, and (2) that comparison of acoustic data or model-crack spectra to permeability-pressure data may elucidate the effects of tortuosity and pinch-off on the conduit porosity.

ROCK-WATER-GAS INTERACTIONS

40772 (LA—7735-M5) **Experimental geothermal loop: II. 200°C study. Informal report.** Charles, R.W. (Los Alamos Scientific Lab., NM (USA)). Apr 1979. Contract W-7405-ENG-36. 43p. Dep. NTIS, PC A03/MF A01.

Reaction of granodiorite from the Fenton Hill Hot Dry Rock Geothermal Site with distilled water at 200°C and 345 bars total pressure for 9 months in a circulation system has produced morphological changes and chemical effects that compare and contrast with a similar experiment done at 300°C reported earlier. Solution samples were taken at 29, 53, 213, 817, 1372, 3147, and 6579 h. Rock disks were removed at 817, 1632, 3147, and 6579 h. Quartz and microcline react congruently. Plagioclase becomes more calcic and is extensively covered by a secondary phase of phillipsite composition. Substrate plagioclase appears to be converted to a sodium laumontite composition. Potassium appears to be leached from the biotite. Chromium appears in the biotite analyses after 9 months indicating reaction of the experimenta system. Calcite vein fillings are deeply etched. All other phases are resistant. Total solution burden is about 200 ppM with silica comprising about 170 ppM. The relative reactivity of major phases is shown to be quartz > plagioclase > microcline > biotite.

ISOTOPE AND TRACE ELEMENT STUDIES

REFER ALSO TO CITATION(S) 40635

WIND ENERGY

40773 Seminar und Statusreport Windenergie. (Seminar and status report on wind energy). Bonn, Germany, F.R.; BMFT (1978). 490p. (In German).

From Seminar and status report on wind energy; Juelich, Germany, F.R. (23 - 24 Oct 1978).

This report contains papers on the meteorological requirements for the operation of wind energy systems and descriptions of small and larger plants, part of them in the planning stage and part of them already in operation.

AVAILABILITY (CLIMATOLOGY)

40774 (PB—287350) **Kauai wind power survey. Part 1. Mobile sampling program, 19 August to 5 September 1977.** Ramage, C.S.; Oshiro, N.E. (Hawaii Univ., Honolulu (USA). Dept. of Meteorology). Nov 1977. 35p. NTIS PC A03/MF A01.

A wind power survey of Hawaii was conducted. A van-mounted anemometer was set up at each of 47 sites for at least 24 hours. The probable long-term average wind speed at each site was estimated by comparing the measured wind speeds to simultaneous observations made at Lihue Airport. This mobile field survey was designed to find where the winds were strongest, to describe their diurnal variation and to identify sites for fixed stations where long period monitoring should be undertaken.

40775 (PB—287361) **Oahu wind power survey, first report.** Ramage, C.S.; Daniels, P.A.; Schroeder, T.A.; Thompson, N.J. (Hawaii Univ., Honolulu (USA). Dept. of Meteorology). May 1977. 44p. NTIS PC A03/MF A01.

A wind power survey has been conducted on Oahu since summer 1975. At seventeen potentially windy sites, calibrated anemometers and wind vanes were installed and recordings made on computer-processable magnetic tape cassettes. From monthly mean wind speeds--normalized by comparing with Honolulu Airport means winds--it was concluded that about 23 mi/hr represented the highest average annual wind speed likely to be attained on Oahu and that the Koko Head and Kahuku areas gave the most promise for wind energy generation. Diurnal variation of the wind in these areas roughly parallels diurnal variation of electric power demand.

WIND ENERGY ENGINEERING

TURBINE DESIGN AND OPERATION

40776 (ANL/CES/TE—78-9) **Wind turbines.** Yeoman, J.C. Jr. (Oak Ridge National Lab., TN (USA)). Dec 1978. Contract W-31-109-ENG-38. 61p. Dep. NTIS, PC A04/MF A01.

This evaluation of wind turbines is part of a series of Technology Evaluations of possible components and subsystems of community energy systems. Wind turbines, ranging in size from 200 W to 10 MW, are discussed as candidates for prime movers in community systems. Estimates of performance characteristics and cost as a function of rated capacity and rated wind speed are presented. Data concerning material requirements, environmental effects, and operating procedures also are given and are represented empirically to aid computer simulation.

POWER CONVERSION SYSTEMS

40777 (UCRL—15005) **Methods of estimating the reliability of wind energy systems with storage.** Glassey, C.R.; Moyer, G.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1978. Contract W-7405-ENG-48. 61p. Dep. NTIS, PC A04/MF A01.

Some preliminary results obtained in analyzing the reliability of wind generator-storage systems are presented. The investigation takes two separate approaches - simulation and probabilistic modeling - to reveal the trade-offs which can be made between generating capacity and storage capacity to attain a desired level of reliability. The performance criterion used throughout this work is the frequency of occurrence of empty storage. This criterion is essentially the same as the frequency of loss of load.

SITE CHARACTERISTICS

40778 (RLO—2444-78/1) **Effect of atmospheric density stratification on wind turbine siting. Final report.** Agopian, K.G.; Crow, S.C. (Poseidon Research Inst., Los Angeles, CA (USA)). Jan 1978. Contract EY-76-C-06-2444. 103p. Dep. NTIS, PC A06/MF A01.

The effect of atmospheric density stratification on the flow-field over isolated terrain features is studied. computer codes for density stratified airflow over two-dimensional and three-dimensional idealized mountains were developed and parametric studies performed to evaluate the sensitivity of the near-ground airflow as a function of ambient wind speed and direction, mountain height and shape, height of the troposphere, stratification in the troposphere, and different inversion conditions. Regions of probable flow separation are predicted using the Stratford separation criterion as applied to turbulent flows.

ELECTRIC POWER ENGINEERING

POWER PLANTS AND POWER GENERATION

REFER ALSO TO CITATION(S) 41339

40779 (EPRI-AF—1041) **Role of personnel errors in power plant equipment reliability. Final report.** Finnegan, J.P.; Rettig, T.W.; Rau, C.A. Jr. (Failure Analysis Associates, Palo Alto, CA (USA)). Apr 1979. 72p. Dep. NTIS, PC A04/MF A01.

This study is a preliminary quantification of the impact of personnel error on the availability of a cross section of fossil fuel power plants. Information was collected from three sources: personal interviews with knowledgeable representatives of nine utilities and staffs of three vendors; analysis of the trouble memos of two utilities; and a survey of 38 utilities. Although the interviews revealed that personnel errors significantly affect equipment availability, specific data are incomplete, emphasize equipment failure rather than human error, and differ greatly depending upon the information source. Written reports and survey data indicate in excess of 20% of all power plant system failures are probably the result of human error.

The resulting loss in power generation capability is estimated to exceed 112,000 MW-hr per average 300 MW unit per y. Boilers and boiler tubes were the component reported to be most often affected by personnel errors, and operator errors are identified more often than maintenance errors. The specific root causes of major problem areas were not clearly identified in most cases, but utilities generally agree that improved training and, to a lesser extent, reduced personnel turnover and equipment designs which better consider human capabilities, will reduce personnel errors.

40780 (FE—2371-36(Vol.3)) **Evaluation of a pressurized-fluidized bed combustion (PFBC) combined cycle power plant conceptual design. Final report. Volume III. Trade-off studies, Subtask 1.3.** Huber, D.A.; Costello, R.M.; Saha, A.K. (Burns and Roe Industrial Services Corp., Paramus, NJ (USA)). Jun 1978. Contract EX-76-C-01-2371. 299p. Dep. NTIS, PC A13/MF A01.

In June 1976, the U.S. Department of Energy (DOE) awarded a contract to an industry team consisting of Burns and Roe Industrial Services Corp. (BRISC), United Technologies Corp. (UTC), and the Babcock and Wilcox Company (B and W) for an "Evaluation of a Pressurized, Fluidized Bed Combustion (PFBC) Combined Cycle Power Plant Design". The results of this program indicate that pressurized, fluidized-bed combustion systems, operating in a combined cycle power plant, offer great potential for producing electrical energy from high sulfur coal within environmental constraints, at a cost less than conventional power plants utilizing low sulfur coal or flue gas desulfurization (FGD) equipment, and at higher efficiency than conventional power plants. As a result of various trade-off studies, a 600 MWe combined cycle arrangement incorporating a PFB combustor and supplementary firing of the gas turbine exhaust in an atmospheric fluidized bed (AFB) steam generator has been selected for detailed evaluation.

40781 (HCP/T2473—24) **Industrial application of fluidized-bed combustion, Phase 1. Quarterly technical progress report, July—September 1978.** (Combustion Engineering, Inc., Windsor, CT (USA)). Apr 1979. Contract EX-76-C-01-2473. 12p. Dep. NTIS, PC A02/MF A01.

The purpose of this program is to develop a commercial atmospheric, natural circulation, fluidized-bed steam generator designed essentially as a package boiler, i.e., shop assembled and capable of shipment by rail. It must be capable of firing coal while meeting all environmental standards without the use of auxiliary SO_2 removal equipment and be competitive with other methods of coal firing for industrial practice. During this quarter, the construction of the Sub-Scale Unit was completed. The major construction changes include revision to the furnace grid plate and addition of refractory to the fourth furnace wall. All walls in the bed zone are now covered to reduce the heat removed from the fluidized bed. Subscale operational tests were run on two types of coal to compare carbon burnout of the char. Low combustion efficiency was experienced with the Old Ben coal. Improved combustion efficiency was achieved in a comparison test with a Western sub-bituminous coal. Demonstration plant site and plant approvals included final issuance of the Environmental Impact Assessment, approval by the State of Illinois of the Air Pollution Control Forms, and initial review and acceptance by EPA of the Prevention of Significant Deterioration (PSD) report. Final design work for the demonstration plant was highlighted by DOE approval of vendor selection for major components in the feedwater, air, and bed material systems. Specifications were prepared or initiated for elements of the fuel feed system, the ash handling system, and the various storage silos. Engineering progress was made inboth the analog and digital control systems. A study was initiated to compare the cost of a 250,000 lb/hr AFBC boiler with the cost of a pulverized coal boiler and flue gas scrubber.

40782 (M—78-68(Vol.2), pp 187-189) **Rivesville installation from the view of the Monongahela Power Company.** McCarthy, H.T. (Allegheny Power System Corp., New York). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Abundant reserves of high sulfur coal are indigenous to northern West Virginia and southwestern Pennsylvania, the geographical areas served by the APS, and where the major electric generating capacity of the system is located. Fluidized bed combustion offers the electric utility industry a method of burning high sulfur coal in an environmentally acceptable manner and, in addition, it reduces the overall cost of generating electricity by eliminating any initial expensive coal beneficiation or cleanup of the exhaust gases. The Rivesville Station, operated by the Monongahela Power Company, was selected as the site for the demonstration project. Rivesville had the advantages of available space within the existing boiler room for the construction of the new boiler using existing concrete lined bunkers for storage of coal and/or limestone with coal handling facilities nearby; availability of local high sulfur coal; appropriate operating and supportive facilities for the test; and an existing turbine—generator with steam conditions of 1270 psig and 925°F, with no reheat that would be compatible with the 300,000 lb/hr packaged unit, the highest capacity factory-assembled boiler in transportable size that could be accommodated in space available in the building.

40783 (MRI—2936-1.0) **Powerplant productivity improvement study. Summary report.** (Mechanics Research, Inc., Santa Monica, CA (USA)). 12 Aug 1977. 62p. Dep. NTIS, PC A04/MF A01.

A summary is presented of a study undertaken to develop methods for evaluating the economic and performance impacts of improving fossil-fuel and nuclear power plants. Information is included on power plant productivity investigation methods, equivalent availability modeling methods, cost and performance analysis methods, and the results of applying these procedures to specific power plant improvements. The results of this study are intended to be useful as a reference methodology for assessing the cost effectiveness of powerplant improvement projects. This methodology can be used by long range planning groups in assessing future system generation and costs. It can be used to evaluate options in the design of new components or systems. It can also be used to substantiate the need for proposed programs aimed at improving unit performance. Furthermore, the study is documented in such a manner that utility personnel not having extensive experience in the abstract areas of reliability engineering, cost estimating, and trend analysis can use the reports to evaluate powerplant productivity improvement projects.

40784 (MRI—2936-5.3) **Powerplant productivity improvement study. Volume II. Analytical techniques for modeling powerplant equivalent availability.** Keller, R.W. (Mechanics Research, Inc., Santa Monica, CA (USA)). 26 Aug 1977. 284p. Dep. NTIS, PC A13/MF A01.

A method is presented which can be employed at relatively low cost by utility personnel to predict changes in future equivalent availability of any existing or planned generating unit on the basis of estimated unit outages, capacity losses and time to restore the unit to service following an outage. This method also provides a quantitative measure of the effectiveness of improvements in equipment reliability and enhances the utility's capability to evaluate the merits of potential reliability-improvement programs.

40785 (MRI—2936-A6.0) **Powerplant productivity improvement study. Volume 1. Methods and techniques for determining the underlying causes and corrective actions of lost powerplant productivity.** Keller, R.W. (Mechanics Research, Inc., Santa Monica, CA (USA)). 29 Jul 1977. 79p. Dep. NTIS, PC A05/MF A01.

This workbook was developed as part of a Federal Energy Agency-sponsored program aimed at providing electric utilities with additional insights, methods and techniques for improving the productivity of their large coal-fired and nuclear power plants. The workbook outlines improved techniques for the gathering, review, and analysis of information on power plant outages and other forms of lost electrical power generation. Information is included on compiling unit data, analyzing unit performance, identifying major organizational and equipment problem areas, and determining underlying causes and corrective actions. (LCL)

40786 (MRI—2936-C4.0) **Powerplant productivity improvement study. Volume III. Cost and performance analysis methods.** Keller, R.W. (Mechanics Research, Inc., Santa Monica, CA (USA)). 24 Aug 1977. 225p. Dep. NTIS, PC A10/MF A01.

Methods developed for the routine, systematic analysis of cost and performance impacts of potential improvements to coal-fired and nuclear power plants are discussed. The information required to apply these methods is assessed. Two case histories are presented, one involving improvements to the electrostatic precipitator and induced draft fans in a fossil-fuel plant, and, the other, improvements to the condensate pumps in a nuclear power plant. (LCL)

40787 (MRI—2936.D6.0) **Powerplant productivity improvement study. Volume IV. Cost/benefit analysis of selected powerplant improvement programs.** Keller, R.W. (Mechanics Research, Inc., Santa Monica, CA (USA)). 27 Jul 1977. 102p. Dep. NTIS, PC A06/MF A01.

The results of cost and performance analyses of 9 improvement programs, 5 at a fossil-fuel plant and 4 at a nuclear power plant, are presented. The performance impacts included improved plant availability, capacity and heat rate. These impacts were converted to dollar values based on reduced plant operating and maintenance costs. It was concluded from the results that these analysis methods are useful in evaluating a wide range of power plant improvements. (LCL)

COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS

REFER ALSO TO CITATION(S) 41321

40788 (EPRI-NP—758(Vol.2)) **Multifrequency eddy current system for steam generator tubing inspection. Volume 2. Analytical studies.** Libby, H.L. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1979. Contract EY-76-C-06-1830. 174p. Dep. NTIS, PC A08/MF A01.

A multifrequency eddy current testing system has been developed to test nuclear steam generator tubes and has been evaluated on a steam generator mockup. Results to date show that use of more than one inspection frequency facilitates electronic assessment of flaw depth, thereby reducing reliance on visual interpretation of signal information by operators. Details on the system design and an evaluation of the system's performance on a steam generator mockup are provided. The system consists of a four frequency signal generator, which excites the inspection coil, followed by a Walsh function instrument which extracts information from any two of the four frequencies present in the composite test signal. The extracted information is processed to discriminate against unwanted signals, such as those from probe wobble, and is then transmitted to the defect decision circuitry for additional processing. Results of the mockup tests show that the system has a higher probability of flaw detection in many cases than does a conventional single frequency test. Tutorial information is presented on algebraic solutions of simultaneous equations and on representation and analysis of signals using orthogonal functions. Examples illustrating the design of the multifrequency inspection system are included. Also presented is an analytical study of several candidate means for implementing electronic assessment of flaw depth.

POWER CYCLES

40789 (CONF-790337—4) **Development of gas turbine fuels and combustion. An overview.** Fejer, A.A. (Institute of Gas Technology, Chicago, IL (USA)). 1979. Contract EX-76-C-01-2433. 12p. Dep. NTIS, PC A02/MF A01.

From New fuels and advances in combustion technologies symposium; New Orleans, LA, USA (26 Mar 1979).

This overview is triggered by the rapidly changing role of the gas turbine in the spectrum of medium and large prime movers for industrial service. It describes the characteristic features of these engines, contrasting them with their chief competitor, the steam cycle. The focus is on the aerodynamic processes in the combustion chambers of traditional engines and includes an outline of the changes that are to be expected with the introduction of the synthetic and coal derived fuels.

40790 (EPRI-AF—1002) **Screening evaluation of novel power cycles integrated with gasification plants. Final report.** Foster-Pegg, R.W.; Garland, R.V. (Westinghouse Electric Corp., Eddystone, PA (USA)). Feb 1979. 136p. Dep. NTIS, PC A07/MF A01.

This report presents the results of a screening study on power cycles integrated with a coal gasification plant. Three basic plant configurations are studied: (1) the Condensing Combined Cycle, the most common combined cycle, which includes combustion turbines, gas expanders and condensing steam turbines. This configuration should be considered as the base case; (2) the Single Cycle, which is comprised of combustion turbines and gas expanders, but no steam turbines; (3) the Non-Condensing Combined Cycle, which utilizes combustion turbines, gas expanders and a non-condensing steam turbine. The gasifier used throughout is the Texaco entrained, coal slurry-fed, air blown gasification system along with a scrubber, sulfur removal system and a tail gas treater. The combustion turbines are advanced types. Nominal turbine inlet temperature in all cases is 2400°F but pressure ratios vary depending upon the particular example. The turbine cooling method is thermal barrier, and both air and steam cooling is applied. Performance and water requirements are compared among the various cycles. The results show that efficient power plants integrated with a coal gasification system are possible and do not necessarily require the condensing steam turbine that is characteristic of combined cycle systems. The most efficient plant configuration studied included a non-condensing steam turbine. The best plant heat rate calculated for this configuration is 7956 Btu/Kwh which compares very favorably to the 8287 Btu/Kwh calculated for the condensing combined cycle. The best system that did not include steam turbines yielded a heat rate of 8039 Btu/Kwh.

WASTE-FUELED SYSTEMS

40791 (LBL—7883) **Characterization of solid-waste conversion and cogeneration systems.** Ritschard, R.L.; Haven, K.F.; Henriquez, M.; Kay, J.; Walzer, W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 15 Aug 1978. Contract W-7405-ENG-48. 226p. Dep. NTIS, PC A11/MF A01.

Recovery of municipal solid wastes (MSW) can reduce the mass of landfilled wastes by as much as 95% and can tap a vast new energy resource. The yearly collection of MSW is estimated to be 125 million tons nationwide. Three basic technologies for recovering energy from MSW are considered, namely: direct combustion using a waterwall incinerator in which heat from burning refuse is converted to steam by circulating water in steel tubes jacketing the interior of the incinerator; manufacture of a relatively uniform shredded, pulverized, or pelleted refuse-derived fuel for supplemental firing in a utility boiler; and pyrolysis or destructive distillation of MSW to extract a low-Btu fuel gas. While resource and energy recovery systems can be installed independently, the processes described here include both energy and resource-recovery systems as well as necessary pollution-control equipment for gaseous emissions. Three end-use applications of cogeneration systems are characterized, including: fluidized-bed cogeneration systems for use in the pulp and paper industry; diesel system using the digested sewage gas of a sewage treatment plant for electricity generation as well as heating and pumping; and an enhanced oil recovery system. Comparisons are made of system inputs per 10^{12} Btu steam output for Landguard pyrolysis, Garrett flash pyrolysis, Union Carbide Purox process, direct combustion, refuse-derived fuels, fluidized-bed cogeneration, diesel cogeneration, and enhanced oil recovery (cogeneration). The RFD system is by far the cheapest to build and is also the most efficient in terms of energy recovery per ton of MSW. The fluidized-bed system has the highest overall system efficiency. However, the PUROX system uses the least ancillary energy and is the only system not requiring an input water flow. Thus the RFD is the most favorable for capital inputs and the PUROX is the most favorable for operational inputs.

COMPONENTS

REFER ALSO TO CITATION(S) 40209, 40210, 40211, 40212, 40213, 40214, 40222, 40233, 40265, 40811, 40812, 41299, 41304, 41462, 41463, 41464, 41465, 41466, 41467, 41468

40792 (ANL—78-62, pp 306-334) **Dynamic simulation of coal based combined cycle plants for development of process control guidelines.** Reddy, G.N. (Argonne National Lab., IL). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

Low Btu gasification/combined cycle power generation (LBG/CCPG) plants and the use of dynamic simulation for developing process control guidelines are described. The formulation of mathematical relationships describing the behavior of various processes within an LBG/CCPG plant (model development) and their solution (simulation) are discussed. A simplified fluidized-bed gasifier model is used as an example. Use of the results of such simulation for developing process control system guidelines is also discussed.

40793 (ANL—78-62, pp 740-774) **Instrumentation and control of a pressurized fluid bed in a combined cycle power plant.** Zoll, A.H. (Curtiss-Wright Corp., Wood-Ridge, NJ). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

The combination of pressurized fluidized bed technology and the gas turbine—steam turbine, combined-cycle power system offers a unique opportunity for the production of electric power from the direct combustion of high sulphur coal that is environmentally acceptable without stack gas cleanup. This paper presents an instrument and control concept which has been applied to a five foot diameter PFB technology rig. Some of the problems are reviewed and the successful application of a process computer is discussed. The Technology Rig effort is keyed to the application requirements of a pilot plant which is being designed and built at the Curtiss-Wright, Wood-Ridge, N.J. facility. The pilot plant process is also presented.

40794 (CONF-790615—4) **Computer program SUPAN: a post processor for the analysis of beam type piping supports.** Nitzel, M.E. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 11p. Dep. NTIS, PC A02/MF A01.

From 3. US national congress on pressure vessels and piping; San Francisco, CA, USA (25 Jun 1979).

Beam-type piping supports may be fabricated from structural members with various cross sectional geometries for situations where standard vendor piping supports may not be adequate or economical. The analysis of these supports in conformance to ASME Code rules is often tedious and time consuming due to the complex loading conditions and numerous support geometries often encountered. Computer program SUPAN has been developed to facilitate the efficient analysis of a large number of supports subject to multiple loading and service conditions. The capabilities of the SUPAN computer program are described. A general discussion of ASME Code requirements and the methodology used for stress calculations are presented. A description of the calculational flow through the program with discussions of program input, output, and programmed error messages is included. Program assets and advantages include increased analyst efficiency, ease of operation, low cost

and run times, automated data checking, and tabular output for inclusion in reports.

40795 (FE—1806-54) **Development of high-temperature turbine subsystem technology to a "technology readiness status". Phase II. Quarterly report for July—September 1978.** Caruvana, A. (General Electric Co., Schenectady, NY (USA)). Oct 1978. Contract EX-76-C-01-1806. 205p. Dep. NTIS, PC A10/MF A01.

The objective of the DOE—HTTT (High Temperature Turbine Technology) program is to bring to "technology readiness," over a six- to ten-year duration, a high-temperature turbine for the use in a combined cycle, using coal-derived fuel at a firing temperature of 2600°F with growth capability to 3000°F. The program has been divided into three phases: phase I--program and system definition, phase II--technology testing and test support studies, and phase III--technology readiness verification test program. The work scope for the overall three phases of the DOE—HTTT program encompasses the design, development, manufacture, and test of a GE—TRV turbine subsystem to be tested at a DOE facility. Phase I was completed and Phase II commenced on August 1, 1977. The objectives of Phase II are to: 1) perform component design and technology testing in critical areas; 2) perform system design and trade-off analyses in sufficient depth to support the component design and test tasks; and 3) update the Phase I combined cycle studies to evaluate the commercial viability of a GE—TRV turbine system.

40796 (FE—2357-33) **CFCC development program. Commercial plant hot gas shrouded ducting evaluation (Task 2.2).** (General Electric Co., Schenectady, NY (USA). Energy Systems Programs Dept.). Jun 1978. Contract EX-76-C-01-2357. 147p. Dep. NTIS, PC A07/MF A01.

The hot gas piping that connects the CFCC plant's final stage of cleanup to its gas turbines must be capable of transporting the process's 1664°F gases safely and with a minimum of heat loss. In addition, the piping must not recontaminate the cleaned gases with any form of particulate or insulation material. The transfer pipe design that best meets these conditions is an internally refractory-lined pipe that uses metallic shrouds to contain and isolate the refractory from the gases. Although this type of line is commercially marketed by Foster Wheeler (FW) for the process industry, it has not been operated at the high temperatures and in the large size diameter required by the CFCC plant. To demonstrate the suitability of its design for this application, a section of shrouded transfer line piping has been built and tested by FW. The test section was heated up to elevated temperature and cooled back to ambient 14 times with the first being for refractory dry out. Five runs were then made to 1650°F at heating rates of 100 and 200°F/hr and five were then made to 1750° at 200°F/hr. In test # 11 the pipe section was temperature cycled between 1400°F and 1750°F to simulate the plant's most severe load increase and load decrease rates, i.e., turn down. Data collected during the runs indicated the pipe section was performing satisfactorily so the section was subjected to even more severe conditions to further demonstrate itscapabilities. The pipe section was heated from ambient to approximately 1400 to 1500°F in two hours and then elevated to approximately 1850°F without showing any signs of hot spots or shroud system breakdown.

40797 (M—78-68(Vol.2), pp 355-373) **Comparison of selected design aspects of three atmospheric fluidized bed combustion conceptual power plant designs.** Garner, D.N.; Howe, W.C.; Dzierlenga, P.S. (Radian Corp., Austin, TX). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

This paper presents a comparison of the basic design parameters and selected design aspects for the three AFBC electric power plant designs being developed by Burns and Roe and Stone and Webster for DOE. Those items of the greatest uncertainty and the largest design variation are discussed, especially with regard to fluidized bed combustion principles applied to a utility boiler. Design assumptions are delineated and their impact on boiler design estimated.

40798 (M—78-68(Vol.2), pp 401-411) **Curtiss—Wright pressurized fluidized-bed pilot electric plant.** Moskowitz, S. (Curtiss—Wright Corp., Wood-Ridge, NJ). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

This paper reviews the DOE sponsored program at Curtiss—Wright for the design, construction and operation of a combined cycle pilot electric plant using the PFB concept for firing high sulfur coal in an environmentally acceptable manner. The pressurized fluidized bed unit is supplied with one-third of the total airflow from the gas turbine's compressor. This air flows through a distributor plate at bottom of the bed and provides air for the combustion process. The other two-thirds of the total air from the compressor flows through a heat exchanger submerged in the fluidized bed. The heat exchanger uses vertically oriented tubes incorporating OD and ID fins. This air which is indirectly heated very close to bed temperature mixes with the hot combustion gas after the gas has been cleaned up by a two stage cyclone type particle separator system. The total flow is supplied to the turbine which drives the compressor and the power turbine which drives the electric generator. The exhaust gas leaving the power turbine flows to an unfired waste heat recovery boiler. With this configuration, 60 percent power output of the combined cycle plant is generated by the gas turbine and 40 percent of the power is generated from the waste heat boiler steam supplied to a steam turbine-generator set. Key design criteria used for this PFB system include the selection of superficial fluidizing velocity, cyclone solids recycling system, and percent excess air in the fluid bed combustor.

40799 (M—78-68(Vol.2), pp 413-432) **General Electric pressurized fluidized bed power plant status.** Brooks, R.D.; Peterson, J.R. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The Pressurized Fluidized Bed (PFB) Combustor in conjunction with Combined-Cycle Power Generation offers the potential for direct combustion of high-sulfur coal without stack gas cleanup, as well as increased power plant efficiency and significantly reduced NO/sub x/ emissions. This paper presents the status of the commercial power plant design and development effort being conducted by General Electric for DOE of a particular power plant approach, termed Coal-Fired Combined Cycle (CFCC). The paper describes the status of the design development work and the degree to which data have been obtained to verify the design assumptions. With respect to the PFB tube bundle, design data have been obtained on a tube bundle of almost identical configuration operated at near design conditions, and the test results obtained have allowed the design conditions to be confirmed. The promise of PFB combined cycle combustion for low emissions has also been verified by test results to date. The turbine hot-part cladding approach employed with the CFCC concept is providing favorable forecasts of gas turbine corrosion life; however, long-term materials testing is still required to verify these forecasts. Fnally, the areas of gas turbine erosion/deposition and corresponding hot-gas cleanup testing require further work before a prudent decision for construction of a commercial utilitt power plant can be reached.

40800 (M—78-68(Vol.2), pp 434-458) **Conceptual design of a coal fueled, fluid bed combined cycle power plant.** Huber, D.A.; Costello, R.M.; Horgan, J.J. Smith, J.W.; Giramonti, A.J.; Smith, J.W. (Burns and Roe Industrial Servies Corp., Paramus, NJ). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Recent studies and research indicate that fluidized-bed coal combustion systems offer the potential for producing electrical energy within present environmental restraints and at a cost less than for conventional coal fired power plants. As a result of various trade-off studies, a 600MW combined cycle arrangement has been selected which incorporates a pressurized fluid bed combustor and supplementary firing of the gas turbine exhaust in an atmospheric fluid bed steam generator. Under Department of Energy sponsorship (ERDA Contract: EX-76-C-01-2371), a conceptual design for such a plant has been prepared and is discussed herein along with preliminary cost estimates.

40801 (M—78-68(Vol.3), pp 714-736) **Turbine materials corrosion in the coal-fired combined cycle.** McCarron, R.L.; Beltran, A.M.; Spacil, H.S.; Luthra, K.L. (General Electric Co., Schenectady, NY). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The alkali (Na + K) in the vapor from a Pressurized Fluidized Bed Combustor (PFBC) may be up to two orders of magnitude greater than the acceptable limit based upon present gas turbine liquid fuel experience. The corrosion conditions developed in the PFBC and gas turbine are analyzed and compared to classic hot corrosion produced by petroleum fuel combustion. Available literature regarding materials performance in PFBC environments is also reviewed, and the probable magnitude of the corrosion problem assessed. Cladding of superalloys with new hot corrosion-resistant materials is a key element in the solution to the corrosion problem which could result if conventional turbine alloy and/or coatings were exposed to this environment. The development of new cladding alloy compositions to resist corrosion from the direct combustion of coal and preliminary results of corrosion evaluations of these alloys will be reviewed.

ECONOMICS

REFER ALSO TO CITATION(S) 40874

OFF-PEAK ENERGY STORAGE

REFER ALSO TO CITATION(S) 41002, 41003

FUELS

REFER ALSO TO CITATION(S) 40105

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 41079, 41762

40802 (PB—287367) **Toward a framework for evaluating the impact of procedural change upon policy: the case of the Kaiparowits environmental impact statement.** Ingram, H.M.; Ullery, S.J. (Lake Powell Research Project, Los Angeles, CA (USA); Arizona Univ., Tucson (USA). Inst. of Government Research; California Univ., Los Angeles (USA). Inst. of Geophysics and Planetary Physics). Aug 1977. 62p. NTIS PC A05/MF A01.

The National Environmental Policy Act (NEPA) of 1969 poses a potentially serious challenge to traditional energy decision-making by requiring decision-makers to consider the environmental impact of energy projects. The extent to which NEPA has effectively imposed upon the planning and construction of powerplants in the Lake Powell region is examined in terms of the substantive effects of NEPA's procedural requirement to prepare environmental impact statements. A review of some of the literature pertinent to this analysis finds the major approaches to evaluating NEPA deficient in some important respects. An alternative approach to evaluating the effect of the impact statement process upon substantive decision-making is offered which emphasizes the opportunities and limitations which NEPA presents to political actors. Finally, a description and analysis of the process by which the environmental impact statement was prepared for the Kaiparowits power project is presented in illustration of the Bulletin's thesis that an overemphasis upon the procedural requirements of NEPA may actually serve to legitimate the decisions which NEPA was intended to alter.

THERMAL EFFLUENTS

REFER ALSO TO CITATION(S) 41705

40803 (EPRI-EA—1054(Vol.2)) **Synthesis and analysis of ecological information from cooling impoundments. Volume 2. Appendix A, study site histories and data synopsis.** Becker, C.D.; Cushing, C.E.; Gore, K.L.; Baker, K.S.; McKenzie, D.H. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1979. Contract EY-76-C-06-1830. 291p. Dep. NTIS, PC A13/MF A01.

A literature review and assessment progam was undertaken to examine the effects of a once-through cooling mode of power plant operation on small, essentially closed aquatic ecosystems, represented by cooling impoundments. The primary objectives were to synthesize existing ecological data from cooling impoundments with a low load ratio (surface area in acres/plant capacity in MWe); to analyze these data to derive technically sound conclusions on plant operational impacts; to identify what important effects cannot be assessed with existing data; to extrapolate the derived conclusions to other ecosystems. Fourteen cooling impoundments were selected on the basis of physical criteria and availability of suitable references. Ecological information related to possible plant operational effects were collected and evaluated for these sites. The primary physical effect was the increment of surplus heat from plant condensers to the water body. Chemical changes were minimal, and were usually associated with long-term evaporation of water. Biological effects were largely qualitative, limited to a portion of the fish and plankton populations, and were not reflected at the community or ecosystem level. Most studies were not designed to quantify potential ecological impacts from power plant operation. Major data deficiencies restricting assessment of ecosystem effects were identified and discussed. To the extent that no major ecosystem effects were identified in "closed" cooling impoundments, they would not be expected in "open" ecosystems.

NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL

REFER ALSO TO CITATION(S) 40062, 40132, 40133, 40134, 40135, 40136, 40137, 40138, 40139, 40140, 40141, 40142, 40143, 40144, 40145, 40146, 40147, 40148, 40149, 40150, 40151, 40152, 40153, 40154, 40155, 40156, 40157, 40158, 40159, 40160, 40161, 40162, 40163, 40164, 40165, 40166, 40167, 40168, 40169, 40172, 40173, 40180, 40204, 40232, 40233, 40259, 40260, 40261, 40262, 40263, 40264, 40793, 41375

40804 (ANL—78-62, pp 588-604) **On-line particle monitoring instrumentation.** Bachalo, W.D. (Spectron Development Labs., Inc., Costa Mesa, CA); Geffken, J.; Weth, G. 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

A light scatter detection particle sizing instrument designed to make measurements of combustion related particulates is described. Two techniques have been incorporated into this instrument. Scattering intensity ratioing is used to measure particle sizes in the 0.5 to 3 μm range and particle sizing interferometry is used in the 3 to 25 μm range. A brief description of the physics concepts involved is given along with the expected performance range of the system.

40805 (ANL—78-62, pp 606-607) **Continuous, in situ particulate mass concentration monitoring via laser light scattering.** Shofner, F.M.; Miller, A.C.; Kreikebaum, G. (Process Particulate Monitors, Inc., Knoxville, TN). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

Design considerations and field performance for a forward scattering mass concentration monitor for hostile process and environmental measurement conditions are described. Microgram/m^3 sensitivities and stabilities are achieved, for micron-size particles, via an electro-optical design whose sensitivity is traceable and automatically compensated.

40806 (ANL—78-62, pp 610-626) **Particle sampling from high temperature and pressure gas streams.** Marlow, W.H.; Abuaf, N. (Brookhaven National Lab., Upton, NY). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

Sampling and characterization needs for HTP aerosols are defined and discussed according to sample representativeness, sample integrity, artifacts of measurement, and validity of the signal. It is argued that for a measurement method to be adequately defined, and therefore have meaning, each of these questions must be addressed. Consequently, a rigorous calibration procedure is an integral part of the design. A candidate HTP probe system for mass determination and how it addresses these questions is described.

40807 (EPA—600/7-78-058a, pp 235-245) **Louisville Gas and Electric Company scrubber experiences and plans.** Van Ness, R.P. Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

This presentation has been divided into two sections. Section I contains an up-to-date report of the progress on the installation of four carbide lime wet scrubbing SO_2 removal systems on electric generating Units at Cane Run Station and Units at Mill Creek Station, and a discussion of the operating experience on the system installed on Unit No. 4 at Cane Run Station, which went in service on August 7, 1976. The progressive installation of these systems is in conformance with a consent agreement negotiated with the US Environmental Protection Agency, Region IV, and the Air Pollution Control District of Jefferson county, Kentucky. Section II contains a preliminary report of the progress on research project under a grant from the Environmental Protection Agency. The project includes: (1) a test program of the operation of the 65-MW Paddy's Run Unit No. 6 marble bed wet scrubber SO_2 removal system under varied operating conditions and with the use of alternate slurry additives (2) studies, integrated with the operating test program, of various methods for the disposal of scrubber sludge in an environmentally acceptable manner.

40808 (EPA—600/7-78-058b, pp 593-615) **Mine disposal of FGD waste.** Johnson, S.L.; Lunt, R.R. (Arthur D. Little, Inc., Cambridge, MA). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

There is substantial capacity for placement of FGD waste in mines in the US. To be technically viable, mines must meet operational criteria of capacity, location, and accessibility. Environmental acceptability must be assessed on a site-specific basis. This paper

discusses the principal potential impact issues requiring evaluation during mine site selection, including groundwater contamination, surface water contamination, sludge stability/consolidation and fugitive air emission. Impact issues of both underground and surface coal mines are discussed relative to the handling and placement techniques considered technically feasible.

40809 (EPA—600/7-78-058b, pp 837-856) **Limestone/gypsum jet bubbling scrubbing system.** Clasen, D.D. (Chiyoda International Corp., Seattle, WA); Idemura, H. Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

A development program initiated to integrate all the chemical and process steps of conventional limestone/gypsum processes into one vessel has led to the development of a new limestone based process employing a new, more efficient gas-liquid contacting device. Flue gas is sparged into the absorbent through an array of vertical spargers generating a froth for efficient gas-liquid contact. SO_2 is absorbed producing sulfite, which is oxidized to sulfate. Oxidizing air from the bottom supplies sufficient oxygen to completely oxidize the sulfite. Benefits derived from this new process are: simplicity of design, lower capital cost, energy conservation, elimination of slurry recycle and L/G in the traditional sense, essentially 100% calcium utilization, saleable or easily disposable gypsum byproduct, and elimination of calcium scaling problems. An extensive research and development program that included operation of a 650-scfm pilot plant was conducted to provide prerequisite data and information for the design and operation of a prototype plant. Construction is now underway on a demonstration plant at Gulf Power Company's Scholz Steam Plant to demonstrate the cost and energy effectiveness and operability of this advanced technology.

40810 (EPA—600/7-78-058b, pp 936-980) **Operating experiences with Kawasaki Magnesium-Gypsum Flue Gas Desulfurization Process.** Tsugeno, H.; Mashita, T.; Itoh, T. (Kawasaki Heavy Industries, Ltd., Akashi, Japan). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

Construction of the first and the second commercial plants using a Magnesium Gypsum Flue Gas Desulfurization Process recently developed by Kawasaki Heavy Industries, Ltd. (KHI) were completed and the trial runs were finished in the beginning of 1976. An outline of the processing equipment, and performance data in the trial runs of the flue gas desulfurization plant for Japan Exlan Co., one of these commercial plants, are summarized. Construction of the Japan Exlan plant was completed at the end of 1975, and it has remained in operation, after a 2-month trial run, since March 1976. In this plant, lime is used as the absorbent agent (with addition of small amounts of magnesium hydroxide) and gypsum is recovered as a byproduct from the plant. A mixed slurry of calcium and magnesium solids is used in the absorber, in which sulfur dioxide removal efficiency is more than 93%. Stable continuous operation, with no trouble of scaling, has been maintained since the trial run. We have found a possibility to refine this process to a high degree, improving on the present Magnesium-Gypsum Process, based on our experiences obtained in the runs at the above commercial plants and on the results of several investigations of our own related to the process. The results of the above investigations and an outline of the improved process are also summarized.

40811 (FE—2357-38) **CFCC development program: materials evaluation and specifications for commercial plant hot gas clean-up (Task 4.2).** (General Electric Co., Schenectady, NY (USA). Energy Systems Programs Dept.). Mar 1978. Contract EX-76-C-01-2357. 21p. Dep. NTIS, PC A02/MF A01.

Of the nine components evaluated, two require major developments to improve predicted lifetimes. These are the sand retaining screens in the granular bed filter and the shrouded ducting which carries the combustion gases to the gas turbine. The valves for the surge and lock hoppers require a limited development program with some testing to insure a satisfactory life and performance. The in-bed steam tubes require a major effort in terms of actual PFB in-bed testing of state-of-the-art materials to accurately establish the suitability of alloys for use at the predicted operating conditions. The secondary cyclone can be constructed from state-of-the-art materials but requires specific limited testing to determine the best balance of performance, life and costs. For the remaining six components it was determined that satisfactory performance and lifetimes would be obtained using state-of-the-art materials and designs without the need for any further testing for verification.

40812 (M—78-68(Vol.2), pp 892-896) **Relative environmental impact of two 570MW atmospheric fluidized-bed electric power generating plants compared to a pulverized coal fired plant equipped with a wet limestone flue gas desulfurization system.** Stone, R.C. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

In January, 1977, the Energy Research and Development Administration contracted with Stone and Webster Engineering Corporation (S and W) to develop a conceptual design of a commercial size (570MW) atmospheric fluidized bed (AFB) electric generating station. This effort was to be basis for a demonstration size (200MW) AFB electric generating station to be funded at a future date by ERDA (now DOE). S and W engaged Pope, Evans and Robbins (PER) to provide AFB technology consulting, and Babcock and Wilcox Company (B and W) and Foster Wheeler Energy Corporation (FW) to develop AFB boiler designs. The AFB boiler size was chosen to permit a direct comparison with an equivalent size conventional pulverized coal (PC) fired plant presently being designed by S and W. As a part of the conceptual design study, S and W is to define the relative environmental effects associated with the AFB plant operation which is the scope of this paper.

40813 (PB—286941) **Chemical analysis of stationary source particulate pollutants by micro-Raman spectroscopy. Interim report, April 1976—March 1977.** Etz, E.S.; Rosasco, G.J.; Heinrich, K.F.J. (National Bureau of Standards, Washington, DC (USA). Analytical Chemistry Div.). Aug 1978. 44p. NTIS PC A03/MF A01.

Analytical capability to identify the principal molecular species present in microparticles is demonstrated on the basis of Raman spectra of selected compounds and materials. Among the inorganic species studied are sulfates, nitrates, carbonates and oxides, for which Raman spectra are discussed for single, solid particles of size down to 1 micrometer. The method of micro-Raman analysis is applied to the molecular characterization of individual microparticles from power plant emissions. Raman spectra have been obtained from microparticles of oil-fired power plant emissions collected by the EPA with cascade impaction samplers. Vanadium pentoxide, V2O5, has been identified as a major component of microparticles present in such samples. The presence of certain other vanadium containing species such as vanadyl, VO(+2), and ortho-vanadate, VO4(-3), is not indicated from the results of these measurements. Other Raman spectra show evidence of crystalline sulfate, SO4(-2), as a species present in major proportions. However, the exact nature of the associated cation specie(s) has not been determined. Many of the spectra obtained from fly ash particles show Raman bands characteristic of polycrystalline graphite apparently due to the presence of carbonaceous material associated with the particles.

40814 (PB—286971) **Effect of SO^2 emission requirements on fluidized-bed combustion systems: preliminary technical/economic assessment. Report for August 1977-January 1978.** Newby, R.A.; Ulerich, N.H.; O'Neill, E.P.; Ciliberti, D.F.; Keairns, D.L. (Westinghouse Research and Development Center, Pittsburgh, PA (USA)). Aug 1978. Contract EPA-68-02-2132. 192p. NTIS PC A09/MF A01.

The report gives results of a preliminary technical/economic evaluation to project the impact of SO^2' control requirements (up to 90% control) on the capital and energy costs of atmospheric-pressure and pressurized fluidized-bed combustion (AFBC and PFBC) power plants. Ability of AFBC and PFBC to reduce emissions of particulates and NOx is also considered. Performance and economic projections are presented, both for the current New Source Performance Standards and for more stringent controls; the AFBC and PFBC projections are compared with equivalent projections for conventional boilers with flue gas desulfurization. The projections show that AFBC and PFBC plants can achieve SO^2 control up to at least 90%, and still remain economically competitive with conventional boilers using scrubbers. However, FBC plant design and operating parameters are critical to the achievement of high levels of SO^2 control at competitive energy costs. In particular, increased gas residence time in the bed, and reduced sorbent particle size, are important in effective attainment of high levels of SO^2 control. The projections of FBC performance at 90% SO2 removal must be confirmed experimentally on FBC units large enough to be representative of commercial-scale combustors.

40815 (PB—286982) **Environmental assessment for residual oil utilization--second annual report. Annual report May 1977—May 1978.** Tyndall, M.F.; Kodras, F.D.; Puckett, J.K.; Symonds, R.A.; Yu, W.C. (Catalytic, Inc., Charlotte, NC (USA)). Sep 1978. Contract EPA-68-02-2155. 183p. NTIS PC A09/MF A01.

The report describes progress in an environmental assessment of processes using residual oil for electric power generation. It presents emissions data from the literature and preliminary sampling, with material balances and flow diagrams for hydrodesulfurization, flue gas desulfurization, partial oxidation, and chemically active fluid bed processes. It describes a computer program for a theoretical engineering analysis that will provide emissions output for the processes studied. A detailed sampling and analysis matrix has been developed that specifies sampling points, procedures, and analyses, including bioassays for all emissions and effluents. Multimedia Environmental Goals (MEGs) and Minimum Acute Toxicity Effluents

(MATEs) are used to develop pollutant prioritization and source analysis models. Methods for developing economic cost models are described.

40816 (PB—287214) **EPA utility FGD survey: February—March 1978. Report for February—March 1978.** Gregory, N.; Isaacs, G.; Laseke, B.; Melia, M.; Patkar, A. (PEDCO-Environmental, Inc., Cincinnati, OH (USA)). Jun 1978. Contract EPA-68-01-4147. 100p. NTIS PC A05/MF A01.

The report is an updated supplement to PB-279 011 and should be used in conjunction with it. It presents a survey of utility flue gas desulfurization (FGD) systems in the U.S., summarizing information contributed by the utility industry, process suppliers, regulatory agencies, and consulting engineering firms. Systems are tabulated alphabetically, by development status (operational, under construction, in planning stages, or terminated operations), by utility company, by process supplier, by process, by waste disposal practice, and by regulatory class. It presents data on system design, fuel sulfur content, operating history, and actual performance. It discusses problems and solutions associated with the boilers and FGD systems. Process flow diagrams and FGD system economic data are appended to the report.

POWER TRANSMISSION AND DISTRIBUTION

REFER ALSO TO CITATION(S) 40547

AC SYSTEMS, EHV AND UHV

40817 (LA-UR—79-385) **Uninterruptable power source for a large computer facility.** Barton, J.; Tolmie, D.E. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 6p. (CONF-790212—3). Dep. NTIS, PC A02/MF A01.

From Association for energy systems, operations, and programming (AESOP) operations managers meeting; Carmel, CA, USA (13 Feb 1979).

An uninterruptable power source was needed to protect critical elements of a computer complex from short power outages and glitches, many of them lightning related. A consultant was hired to help in this task and proved invaluable. The equipment purchased provides glitch-free power under many fault conditions. Installation proved to be a major problem as far as money and time were concerned. The system is now ready to be switched over to drive the critical load. The project appears to be a success and should pay for itself many times over.

SUPERCONDUCTING AND CRYOGENIC SYSTEMS

REFER ALSO TO CITATION(S) 41400

40818 (BNL—26016) **AC superconducting cables.** Forsyth, E.B. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 26p. (CONF-790527—2). Dep. NTIS, PC A03/MF A01.

From Workshop on public policy aspects of high capacity electric power transmission; Aspen, CO, USA (14 May 1979).

The characteristics and economics of superconducting power transmission cables are discussed, and major research projects on these cables are described. At present Austria is the only European country continuing this research. The USSR has an active program and U.S. efforts are concentrated at the Brookhaven Laboratory which is constructing a 100 m-long 138 kV test facility. (LCL)

NUCLEAR POWER PLANTS

REFER ALSO TO CITATION(S) 40783, 40784, 40785, 40786, 40787, 41339, 41390

40819 (INIS-mf—4513) **Annual report 1977.** (Stichting Energieonderzoek Centrum Nederland, The Hague). Jun 1978. 92p. (In Dutch). Dep. NTIS (US Sales Only), PC A05/MF A01.

The change of statute made in 1976 has been followed by a shift of emphasis towards non-nuclear subjects in the ECN Research Centre. A performance testing of experimental wind turbines to be installed at the Petten site, is done in the framework of the national energy R and D programmes. An effort on technical superconductors and superconducting coils became the subject of a cooperation with the Netherlands Applied Research Organisation TNO and some industrial companies. Programmes on magnetohydrodynamic conversion and on energy storage in flywheels are in advanced preparation. A large experimental effort is devoted to the fast reactor development programme of Germany, Belgium and the Netherlands. Complete is the estimation of the reactivity effects of fission products in the prototype fast reactor under construction at Kalkar. The HFR will also be used in a new series of transient overpower experiments on fast reactor fuel pins. ECN activities in the nuclear fuel cycle are concentrated on the disposal of radioactive work in salt domes.

40820 (INIS-mf—4632) **Implications of nuclear export policies and trade on the current and future development in Spain.** Sanchez, J.L. (Centrales Nucleares del Norte, S.A. (NUCLENOR), Madrid (Spain)). 1978. 12p. (CONF-780584—2). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on regulating nuclear energy; Brussels, Belgium (16 May 1978).

This paper deals with the status of the Spanish nuclear programme. The 1964 Act on nuclear energy authorizes the Spanish Government to conclude bilateral agreements enabling Spain to benefit from the transfer of advanced technologies. In this context, Spain signed an agreement with the U.S. on 20 March 1974 and another agreement with IAEA and the U.S. in June 1974. The paper also envisages the consequences of the U.S. 1978 Non-Proliferation Act on Spain's nuclear activities: need to renegotiate the present agreements, loss of confidence in view of the new conditions imposed (restrictions in export licences) and practical implementation for the three Spanish installations which use enriched fuel of American origin.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 40913, 40914, 40915, 40922, 40937, 40941, 40956, 40957, 40961, 40962, 40963, 40964, 40978

40821 (COO—4066-8) **Fuel performance improvement program. Quarterly/annual progress report, October 1977—September 1978.** Crouthamel, C.E. (comp.). (Exxon Nuclear Co., Inc., Richland, WA (USA)). Oct 1978. Contract EY-76-C-06-1830. 170p. Dep. NTIS, PC A08/MF A01.

This quarterly/annual report reviews and summarizes the activities performed in support of the Fuel Performance Improvement Program (FPIP) during Fiscal Year 1978 with emphasis on those activities that transpired during the quarter ending September 30, 1978. Significant progress has been made in achieving the primary objectives of the program, i.e., to demonstrate commercially viable fuel concepts with improved fuel - cladding interaction (FCI) behavior. This includes out-of-reactor experiments to support the fuel concepts being evaluated, initiation of instrumented test rod experiments in the Halden Boiling Water Reactor (HBWR), and fabrication of the first series of demonstration rods for irradiation in the Big Rock Point Reactor (BRPR).

40822 (NEDC—23856) **Alternate water chemistry program. Quarterly report 1, from program start to December 31, 1977.** Burley, E.L. (General Electric Co., San Jose, CA (USA). Nuclear Energy Engineering Div.). Aug 1978. Contract EY-76-C-02-2985. 52p. Dep. NTIS, PC A04/MF A01.

Boiling water reactors (BWR) generally use high-purity, no-additive feed water. The primary recirculating coolant/moderator water is continuously purified in an ion exchanger clean-up system so that even trace impurity levels are exceptionally low. However, the radiolytic decomposition of water in the reactor flux proceeds at a significant rate to produce 200 pounds O_2 and 25 pounds H_2 in an operating 2500 MWt reactor per hour. Although the bulk of these gases is stripped into the steam and removed from the system at the condenser, a small fraction stays with the recirculating liquid phase so that it contains 100 to 300 ppB of dissolved oxygen and stoichiometric amounts of dissolved hydrogen. There is substantial evidence that water oxygenated to this level increases austenitic stainless steel susceptibility to intergranular stress corrosion cracking when other requisite factors such as stress and sensitization are present. Thus, reduction or elimination of the oxygen in BWR water may preclude cracking incidents. One approach to reduction of the BWR coolant oxygen concentration is to adopt alternative water chemistry conditions using an additive or additives to suppress or reverse the radiolysis reaction. Several additives are available for suppressing the coolant oxygen content but they have seen only limited and specialized application in BWRs. The objective of the program is to perform an in-depth engineering evaluation of the potential suppression additives supported by critical experiments, where required, to resolve substantive uncertainties. On the basis of the engineering evaluation, the optimum oxygen suppression approach or approaches will be selected and a specific BWR plant recommended for an extended (3-year) plant demonstration experiment.

40823 (NUREG/CR—0211) **Postirradiation examination data report for GAP conductance test series. Test GC 2-2.** Kerwin, D.K. (Idaho National Engineering Lab., Idaho Falls (USA)). May 1978. Contract EY-76-C-07-1570. 260p. (TREE-NUREG—1206). Dep. NTIS, PC A12/MF A01.

The results of the postirradiation examination of four previously unirradiated boiling water reactor type, zircaloy-clad, UO_2-fueled rods tested in Gap Conductance Test GC 2-2 in the Power Burst Facility are discussed. Test GD 2-2 was performed to obtain experimental data from which test fuel rod gap conductance and effective fuel thermal conductivity values could be determined. The postirridation examination results aid in interpreting the experimental data obtained during the test and in evaluating the effect of rod design on fuel rod thermal response and gap conductance. Fuel rod fill gas composition and pressure are discussed. Fuel pellet-to-cladding gap widths and gap and fuel crack areas are presented. The fuel structures are analyzed. Test rod thermocouples are examined and axial power profiles determined to aid in subsequent evaluation of instrument performance and test rod thermal response.

40824 (NUREG/CR—0507)Vol.3)) **Stress analysis of cylindrical pressure vessels with closely spaced nozzles by the finite-element method. Volume 3. Vessels with three nozzles under internal pressure and external loadings.** Tso, F.K.W.; Weed, R.A. (Oak Ridge National Lab., TN (USA)). 3 Apr 1979. Contract W-7405-ENG-26. 59p. (ORNL/NUREG—18/V3). Dep. NTIS, PC A04/MF A01.

A finite-element computer program, MULT-NOZZLE, was developed for the stress analysis of cylindrical pressure vessels with one, two, or three closely spaced reinforced nozzles. The nozzles may be unreinforced or fully reinforced according to the rules of the ASME Boiler and Pressure Vessel Code. The program consists of two modules that may be operated independently. The first module, FEMG, automatically prepares a finite-element mesh, including the nodal point coordinates, finite-element connectivities, mesh options, and boundary value specifications for input to the finite-element solution module SAP3M. SAP3M, which is a modified and improved version of the SAP3 computer program, computes the nodal point displacements and stress tensor components and prints and/or stores the results for later postprocessing.

40825 (NUREG/CR—0649) **Spent fuel heatup following loss of water during storage.** Benjamin, A.S.; McCloskey, D.J.; Powers, D.A.; Dupree, S.A. (Sandia Labs., Albuquerque, NM (USA)). Mar 1979. Contract EY-76-C-04-0789. 163p. (SAND—77-1371). Dep. NTIS, PC A08/MF A01.

An analysis of spent fuel heatup following a hypothetical accident involving drainage of the storage pool is presented. Computations based upon a new computer code called SFUEL have been performed to assess the effect of decay time, fuel element design, storage rack design, packing density, room ventilation, drainage level, and other variables on the heatup characteristics of the spent fuel and to predict the conditions under which clad failure will occur. Possible storage pool design modifications and/or onsite emergency action have also been considered.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 40821, 40824, 40825, 40876, 40897, 40913, 40915, 40916, 40919, 40922, 40936, 40939, 40944, 40955, 40956, 40957, 40959, 40961, 40975, 40980, 40983, 40985

40826 (UCID—18018) **Free vibration analysis of a steam generator tube bundle with and without lateral support.** King, D.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Apr 1979. Contract W-7405-ENG-48. 184p. Dep. NTIS, PC A09/MF A01.

The vibrational modes and frequency characteristics of a pressurized water reactor (PWR) steam generator tube bundle assembly with and without lateral support in a fluid environment are analyzed. The idealized half-model was constructed using the SAP-IV finite element code. Free vibration analyses were performed for an in-air case and a submerged in-water case, each with different constraint conditions at steam generator tube bundle assembly support plates 10 and 11. These constraint conditions included having both support plates free, having both support plates fixed, and having support plate 11 free while support plate 10 was fixed. It was found that as the support plate constraints were removed, the frequency range for each case increased significantly.

40827 **Steam generator and pressurized-water nuclear reactors.** Stoll, A.; Kelp, F. (to Kraftwerk Union Aktiengesellschaft). US Patent 4,148,281. 10 Apr 1979. Priority date 22 Mar 1976, German, Federal Republic of (F.R. Germany), 4p.

A steam generator for pressurized-water nuclear reactors is described having a steam jacket wherein a multiplicity of rectilinear tubes traversed by primary water is secured between two horizontally disposed tube support plates, and at least one connecting tube for supplying the primary water is secured to the steam jacket through a compensator for length equalization, includes a water chamber respectively disposed within the steam jacket and adjoining each of the tube support plates, and a guide jacket for circulating feed-water supplied into the steam jacket, the guide jacket being mounted within the steam jacket and having a lower portion extending into a space located between the steam jacket and the lower tube support plate.

40828 (DOE/TIC—10050) **Application of the response surface method of uncetainty analysis to establish distributions of FRAPS3 calculated stored energy for PWR-type fuels.** Kerrigan, J.D.; Coleman, D.R. (Idaho National Engineering Lab., Idaho Falls (USA)). [nd]. Contract EY-76-C-07-1570. 52p. Dep. NTIS, PC A04/MF A01.

An uncertainty analysis was performed using the steady state fuel rod analysis program, FRAP-S3, to establish burnup-dependent distributions of fuel stored energy. The response surface methodology used for conducting the analysis is briefly discussed. The distributions of fuel stored energy obtained as a result of the uncertainty analysis reflect uncertainties in the FRAP-S3 model in addition to uncertainties in PWR fuel rod design and operating power. An assessment is made of the adequacy of these distributions to represent initial accident conditions for a typical PWR core. The relative influence individual input variables on the integal uncertainty of computed output is discussed. Applications of the results of this study are presented. Emphasis is placed upon the utilization of the results to quantify evaluation model conservatism.

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

REFER ALSO TO CITATION(S) 40894, 40958, 41267

40829 (CONF-770807—Pt.L, pp vp) **Creep and corrosion of nickel- and molybdenum-base alloys.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

40830 (ORNL/TM—6797) **Corrosion of Alloy 800H in caustic-contaminated superheated steam at 538°C (1000°F).** Griess, J.C.; Maxwell, W.A. (Oak Ridge National Lab., TN (USA)). May 1979. Contract W-7405-ENG-26. 17p. Dep. NTIS, PC A02/MF A01.

Alloy 800H has very high corrosion resistance to high-temperature steam and is a promising material for superheater tubes in high-temperature gas-cooled reactors. The material, however, is susceptible to stress-corrosion cracking in some caustic environments. Experience at fossil fired power plants has shown that excursions in the sodium concentration of the boiler feed water brought about by load changes can result in sodium concentrations of 20 to 30 ppB in the steam for short times. Consequently, we conducted this experimental program to determine if sodium dissolved in steam at this level adversely affects corrosion of Alloy 800H. The corrosion resistance of four heats of Alloy 800H was determined in superheated steam containing 20 to 30 ppB Na as sodium hydroxide at 538°C (1000°F). Two of the heats contained the specified minimum carbon content (0.05%), and two contained near the maximum (0.10%). The test was conducted in a once-through loop at an operating power plant and used plant steam into which a dilute solution of sodium hydroxide was injected. Specimens stressed to 90% of the ASME design yield stress showed no signs of stress-corrosion cracking or other forms of localized attack during a 3991-h test. All four heats of the alloy corroded at 6.1 μm/year (0.24 mil/year), which though higher than in pure stream was still low.

40831 **Comparison of pyrolytic carbon microstructures derived from MAPP-gas and propylene.** Krautwasser, P.; Yust, C.S.; Tennery, V.J.; Beatty, R.L. (Oak Ridge National Lab., TN). pp 467-476 of Ceramic microstructures '76: with emphasis on energy related applications. Fulrath, R.M.; Pask, J.A. (eds.). Boulder, CO; Westview Press (1977).

From 6. international symposium - ceramic microstructures '76; Berkeley, CA, USA (24 Aug 1976).

The microstructure of pyrocarbon HTGR fuel particle coatings formed by pyrolysis of organic gases is strongly dependent on the deposition conditions. Microstructural variations induced by change of deposition gas have been studied by use of small x-ray scattering, transmission electron microscopy and plasma oxidation etching. The combined use of these techniques and others to define the microstructure is discussed.

POWER REACTORS, BREEDING

REFER ALSO TO CITATION(S) 40909, 40911, 40912, 40924, 40929, 40930, 40933, 40935, 40943, 40945, 40946, 40948, 40949, 40950, 40952, 40960, 40967, 40968, 40971, 40981, 40982, 40991, 41202, 41223, 41224, 41267

40832 (ANL—77-73) **Model for turbulent momentum and heat transport in large rod bundles.** Sha, W.T.; Launder, B.E. (Argonne National Lab., IL (USA)). Jan 1979. Contract W-31-109-ENG-38. 32p. AT.

A quasi-continuum model for turbulent momentum and heat transport in large rod bundles has been developed. This model has been derived from a subchannel analysis and adapted to a quasi-continuum form by introducing concepts of porosity and distributed resistance. The effects of turbulent kinetic energy generation due to shear, viscosity, diffusion, geometric effects, buoyancy, and Reynolds number are explicitly included. The proposed model of turbulence is relatively simple, yet it is believed to provide a framework for taking account of important turbulent mechanisms in rod bundles.

40833 (CONF-770807—Pt.E, pp vp) **Finite-element formulations for the thermal stress analysis of two- and three-dimensional thin ractor structures.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper describes finite-element formulations for the thermal stress analysis of LMFBR structures. The first formulation is applicable to large displacement rotation problems in which the strains are small. For this formulation, a general temperature-dependent constituent relationship is derived from a Gibbs potential function and a temperature dependent yield surface. The temperature dependency of the yield surface is based upon a temperature-dependent, material-hardening model. The model uses a temperature-equivalent stress-plastic strain diagram which is generated from isothermal uniaxial stress-strain data. A second formulation is presented for problems characterized by both large displacement-rotations and large strains. Here a set of large strain hypoelastic-plastic relationships are developed to linearly relate the rate of stress to the rate of deformation. The temperature field is described through time-dependent values at mesh node points; the temperature fields in each element are then obtained by interpolation formulas. Hence, problems with both spatial and temporal dependent temperature fields can easily be treated. The above developments were incorporated into two ANL developed finite-element computer codes: the implicit version of STRAW and the 3D Implicit Structural Analysis Code. STRAW is a two-dimensional code with a plane stress/plane strain beam element. The 3D Implicit code has a triangular flat plate element which is capable of sustaining both membrane and bending loads. To insure numerical stability both codes are based on an iterative-incremental solution procedure with equilibrium checks based on an error in energy.

40834 (CONF-770807—Pt.F, pp vp) **From Phenix to Super Phenix: mechanical structures assuring reactor vessel tightness at main sodium pump penetrations.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Even though the components of SUPER PHENIX are larger than those of PHENIX, there is no corresponding increase in available vessel height. Furthermore the SUPER PHENIX vessel does not possess a roof. For these reasons, original and patented solutions, which, nevertheless, take advantage of the experimental results and operating experience acquired with PHENIX, were sought. The most important parameters are: weights and sizes of various components; stresses transmitted to the structures differential displacements between the top and bottom positions of components; inclinations due to deformation of the deck; preservation of containment at places where components penetrate the deck. In the solution finally adopted, an elastic torus shaped ring, which forms a ball-and-socket type joint is used. A thin shell structure connects the bottom to the reactor internals in such a way as to permit both vertical and rotational displacements. The upper joint consists of: a bolted double flange system; flanged component; a torus with a gear tooth shape profile made of elastic material; leaktight bellows attached to both flanges. Studies and calculations have been completed with the realization of a 1/5 scale model of the upper torus ring. Displacement, and angular and axial stiffness measurements have confirmed the validity of the hypotheses. Moreover, even though the lower part is an extrapolation of PHENIX, full scale experimental tests have been carried out in sodium, reproducing the real displacements and forces that will be experienced in the reactor. Finally, the pumps will be tested with water; the suspension will be studied (investigation of relevant mechanical parameters, measurement of leaktightness with respect to the outside).

40835 (CONF-780819—P1, pp 195-207) **Study on the tritium removal from the sodium in LMFBR.** Hata, K.; Nishizawa, Y.; Osawa, Y. (Mitsubishia Atomic Power Industries, Inc., Omiya, Japan). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Removal of tritium in the sodium coolant of LMFBR, is important for achieving the release of radioactivities as low as reasonably achievable. It is well known that cold trap should be an effective method for controlling tritium in sodium. To develop an effective tritium trapping system with reactive getter (chemical trap), in-sodium hydrogen absorption behavior has been studied. The absorption experiment was conducted by dipping some test materials into sodium on which cover gas was composed of an Ar-H_2 mixture. Hydrogen analysis and metallographic examination for the test materials were made after the experiment. From these experiments, it was concluded that Yttrium canned with Nickel or Niobium was the most suitable as reactive getter. Further investigation to develop the chemical trap made from these materials for practical application has been in progress.

40836 (COO—2458-24) **Simple procedure for determining implications of design changes on fast reactor fuel cycle cost and breeding performance.** Badruzzaman, A.; Becker, M. (Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Nuclear Engineering). 1979. Contract EY-76-S-02-2458. 6p. (CONF-790602—18). Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; Atlanta, GA, USA (3 Jun 1979).

Recently, analytical sensitivity methods has been applied to obtain fuel cycle cost implications of data uncertainties. To perform exposure dependent sensitivity analysis without repeating expensive spectrum calculations, simple correlations of the spectrum averaged cross sections (SAXS) were constructed. The correlation coefficients were obtained by fitting the SAXS calculated by direct methods over a wide range of LMFBR core designs. In this paper the procedure has been extended to study sensitivity of fuel cycle cost and breeding ratio to design variation. The method involves using the correlations to construct both the SAXS and the sensitivity coefficients. Composition dependent correlations have been found to be accurate for the core while both composition and position have to be included in analysing the blanket.

40837 (CRBRP-ARD—0230) **Clinch River Breeder Reactor Plant Project. 1978 technical progress report.** (Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.). 1978. Contract EW-76-C-15-2395;EW-76-C-15-0003. 379p. AT.

This technical progress report on the Clinch River Breeder Reactor Plant Project describes the objectives, design decisions, and major accomplishments achieved in the planning, organizing, design, and licensing of the Clinch River Breeder Reactor Plant (CRBRP). In this report period, fabrication of components continued. Several components were completed, the most significant being the cold-leg check valves. Fabrication of the reactor vessel passed the 80-percent completion stage. All licensing action remains suspended until decisions regarding the Project have been made by the Administration and Congress.

40838 (GEFR—00340) **Acoustic leak detection system concept design.** Greene, D.A. (General Electric Co., Sunnyvale, CA (USA). Fast Breeder Reactor Dept.). Jan 1978. Contract EY-76-C-03-0893-030. 101p. AT.

Design criteria are developed for acoustic monitoring of small sodium-water reactions in an LMFBR steam generator. From these criteria a concept design of an acoustic leak detection system has been prepared. The system description includes discussions of predicted system costs, expected system performance, mode of operation, and reactor manufacturers target cost criteria for leak protection systems. It is concluded that an acoustic system is feasible for LMFBR steam generators.

40839 (GEFR—00400) **Interim report: leak detection test activities on the General Electric Steam Generator Test Rig (SGTR).** Stehling, S.G.; Magee, P.M. (General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.). Sep 1978. Contract EY-76-C-03-0893-030. 71p. AT.

Leak detection equipment and their associated control and instrumentation systems have been developed under Base Development Program SG027, Subtask X1, to detect the reaction products which evolve from the reaction of sodium with small quantities of water in LMFBR steam generators. The prototype leak detector characterization tests which have been initiated in the General Electric Steam Generator Test Rig (SGTR), in conjunction with the Few Tube Test (FTT) Program, are the first in a series of tests designed to assure the adequacy of the system design for commercial

LMFBR plant utilization. The SGTR tests are the first time the prototype Clinch River Breeder Reactor (CRBR) design leak detectors are tested, and the primary emphasis of the tests is on system operation and procedure checkout, with secondary emphasis placed on obtaining signal resolution and transit time date.

40840 (GEFR—00417) **PACT 2: probabilistic analysis of coolant and cladding temperatures.** Chen, K.H.; Hoover, D.G. (General Electric Co., St. Petersburg, FL (USA). Pinellas Peninsula Plant). Jun 1978. Contract EY-76-C-03-0893-031. 239p. AT.

The PACT 2 code computes the probability distributions of the coolant and cladding temperatures throughout a single LMFBR fuel assembly during steady state operation at start of life. The PACT 2 code is an improved version of PACT. It uses a mathematical model that considers both thermal-hydraulics in coolant subchannels and Monte Carlo sampling of the thermal-hydraulic calculation. The coolant temperature in each nodalized coolant subchannel is defined as a function of enthalpy, flowrate, crossflow between adjacent subchannels, heat flux, and position. The mathematical model neglects the redistribution of subchannel coolant flow; therefore, it is limited to fuel pin assemblies in which there is no flow blockage. The equations of the mathematical model for the thermal-hydraulic calculation are solved by using a forward marching finite difference scheme.

40841 (GEFR—00422) **Transition joint welding: life test article fabrication.** Hartle, R.T.; Busboom, H.J.; Ring, P.J. (General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.). Dec 1978. Contract EY-76-C-03-0893-030. 90p. AT.

This work is in support of the Clinch River Breeder Reactor (CRBR), a demonstration plant funded jointly by the Department of Energy and the Project Management Corporation. The objective of this task was to improve the conventional transition joint design and develop welding fabrication techniques for these improved joints. The joints for CRBR form the sodium side transitions between ferritic and austenitic stainless steel piping within the Intermediate Heat Transfer System (IHTS). These joints vary in size from 1 inch, Schedule 80 up to 26.0 inches, and are required to perform successfully throughout a design life of 30 years (~ 263,000 hours).

40842 (GEFR—13771-29) **Critical experiments and analysis. Twenty-ninth quarterly report, October—December 1978.** (General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.). Jan 1979. Contract EY-76-C-03-0893-031. 63p. AT.

Current activities and technical progress for the period October through December 1978 are reported. This report covers the technical direction for critical experiments and analysis as applicable to LMFBR commercial plants and the Clinch River Breeder Reactor Plant Benchmark Critical Experiments in ZPPR Assembly 4 and the CRBRP EMC.

40843 (HEDL-SA—1518) **Experimental fuel assembly irradiation experience in EBR II.** Jackson, R.J.; Kaplan, S.; Schwaille, A. (Hanford Engineering Development Lab., Richland, WA (USA)). Nov 1978. Contract EY-76-C-14-2170. 19p. (CONF-790306—8). Dep. NTIS, PC A02/MF A01.

From International conference on fast breeder reactor performance; Monterey, CA, USA (5 Mar 1979).

Irradiation and laboratory tests at EBR-2 of fuel assembly bundles having features prototypic of fast breeder fuel assembly design are described. Much of the work was on fuel bundles design for FFTF.

40844 (HEDL-SA—1527-FP) **Fuel-cladding chemical interaction in mixed-oxide fuels.** Lawrence, L.A.; Weber, J.W.; Devary, J.L. (Hanford Engineering Development Lab., Richland, WA (USA)). Oct 1978. Contract EY-76-C-14-2170. 14p. (CONF-790306—13). Dep. NTIS, PC A02/MF A01.

From International conference on fast breeder reactor performance; Monterey, CA, USA (5 Mar 1979).

The character and extent of fuel-cladding chemical interaction (FCCI) was established for UO_2-25 wt% PuO_2 clad with 20% cold worked Type 316 stainless steel irradiated at high cladding temperatures to peak burnups greater than 8 atom %. The data base consists of 153 data sets from fuel pins irradiated in EBR-II with peak burnups to 9.5 atom %, local cladding inner surface temperatures to 725°C, and exposure times to 415 equivalent full power days. As-fabricated oxygen-to-metal ratios (O/M) ranged from 1.938 to 1.984 with the bulk of the data in the range 1.96 to 1.98. HEDL P-15 pins provided data at low heat rates, ~ 200 W/cm, and P-23 series pins provided data at higher heat rates, ~ 400 W/cm. A design practice for breeder reactors is to consider an initial reduction of 50 microns in cladding thickness to compensate for possible FCCI. This approach was considered to be a conservative approximation in the absence of a comprehensive design correlation for extent of interaction. This work provides to the designer a statistically based correlation for depth of FCCI which reflects the influences of the major fuel and operating parameters on FCCI.

40845 (HEDL-SA—1631-FP) **Fuel crack volume predictions and measurements.** Fox, G.L.; Randklev, E.H. (Hanford Engineering Development Lab., Richland, WA (USA)). Jan 1979. Contract EY-76-C-14-2170. 13p. (CONF-790310—5). Dep. NTIS, PC A02/MF A01.

From Specialists workshop on predictive analysis of material dynamics in LMFBR safety expts; Los Alamos, NM, USA (13 Mar 1979).

Void volume within an LMFBR fuel pin has a substantial effect on calculations of cladding strain and lifetime for transient overpower accident analyses. A substantial fraction of this void volume is contained within startup cracks that are still present during fuel irradiation. The paper discusses a crack prediction method and crack measurement techniques, compares predictions with measurements, and includes a sufficient crack fraction data base to be of use to other fuel pin behavior analysts.

40846 (INIS-mf—4623) **Example of regulating process for an advanced reactor: Creys-Malville.** Cravero, M. (Electricite de France, 92 - Courbevoie. Service Etudes et Projets Thermiques et Nucleaires). 1978. 18p. (CONF-780584—4). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on regulating nuclear energy; Brussels, Belgium (16 May 1978).

The general philosophy for the regulatory control of the Super-Phenix fast breeder reactor was the same as for other types of nuclear power plants. The licensing process for both conventional and nuclear aspects was also identical to that for other nuclear units. On the other hand, safety recommendations were especially prepared by the CEA's appropriate services on the basis of acquired experience. The paper analyses the development of the licensing process for the reactor and knowledge to be gained for future units of this type.

40847 (LA—7570-PR) **Advanced fast reactor fuels program. Second annual progress report, July 1, 1975—September 30, 1976.** Baker, R.D. (comp.). (Los Alamos Scientific Lab., NM (USA)). Dec 1978. Contract W-7405-ENG-36. 114p. Dep. NTIS, PC A06/MF A01.

Results of steady-state (EBR-II) irradiation testing, off-normal irradiation design and testing, fuel-cladding compatibility, and chemical stability of uranium—plutonium carbide and nitride fuels are presented.

40848 (LA—7678-PR) **Examination of fast reactor fuels, FBR analytical quality assurance standards and methods, and analytical methods development: irradiation tests. Progress report, October 1—December 31, 1978.** Baker, R.D. (comp.). (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 11p. Dep. NTIS, PC A02/MF A01.

This is the seventeenth quarterly report on the Examination of Fast Reactor Fuels and Fast Breeder Reactor (FBR) Analytical Quality Assurance and Methods of the Los Alamos Scientific Laboratory. Since the first quarterly report (LA-5798-PR), the Anaytical Quality Assurance Standards and Methods project has been divided into the following two projects: FBR Analytical Quality Assurance Standards and Methods; and Analytical Methods Development - Irradiation Tests. Most of the investigations discussed here are of the continuing type. Results and conclusions described may therefore be changed or augmented as the work continues.

40849 (ORNL/SUB—4485/2) **Development of the PLANS computer program for elastic—plastic-creep analysis of nuclear reactor structural components.** Levy, A. (Grumman Aerospace Corp., Bethpage, NY (USA). Research Dept.). Jan 1979. Contract W-7405-ENG-26. 34p. AT.

This report summarizes the continued development of computationally efficient finite-element methods for accurately predicting the isothermal three-dimensional elastic—plastic-creep responses of thick and thin shell structures subjected to mechanical and thermal loads. This work is directed toward verifying the structural integrity of liquid metal fast breeder reactor (LMFBR) components in the creep regime. The most recent developments include the use of multistress points within an element, temperature variation within an element, combined time dependent creep and isothermal plasticity, and restart capabilities.

40850 (ORNL/TM—6782) **Influence of melting practice and heat treatment on the continuous cycling fatigue and subcritical crack growth properties of 2 1/4 Cr—1 Mo steel.** Strizak, J.P.; Brinkman, C.R. (Oak Ridge National Lab., TN (USA)). May 1979. Contract W-7405-ENG-26. 33p. AT.

Interim results are reported for continuous cycling strain-controlled fatigue and fatigue crack growth tests of 2 1/4 Cr—1 Mo steel. Heat-to-heat variations due to different melting practices and postweld heat treatment of annealed and isothermally annealed material were considered. Apparently, continuous cycle fatigue behavior at 427 and 538°C did not differ among the heats manufac-

tured by air-melt, vacuum-arc remelt, and electro-slag remelt practices. Furthermore, a possible postweld heat treatment of 40 h at 726°C on initially annealed or isothermally annealed material did not influence continuous cycle fatigue life. Interim fatigue crack growth rate results at 510°C extended data to higher stress intensity levels. Fatigue crack growth rate data for isothermally annealed air-melt material obtained at frequencies of 0.067 and 0.67 Hz over a stress intensity range of 30 to 60 MPa $\sqrt{m}$ agreed well with previous results not exceeding 40 MPa $\sqrt{m}$. Cyclic life tests using both hourglass-shaped and uniform-gage specimens were compared. The 5.08-mm-diam hourglass-shaped specimen had a lower fatigue life than the 6.35-mm specimen. The discrepancy in the results for these two hourglass-shaped specimens decreases with decreasing total axial strain range. Furthermore, the uniform-gage specimen had a lower fatigue life than the 6.35-mm-diam hourglass-shaped specimen.

40851 (WAPD-TM—1226) **LWBR automated fuel rod loading verification gage system (LWBR Development Program.** Kotula, J. (Bettis Atomic Power Lab., West Mifflin, PA (USA)). Feb 1979. Contract EY-76-C-11-0014. 24p. Dep. NTIS, PC A02/MF A01.

The Automated Fuel Rod Loading Verification Gage System was used to inspect fuel rods, manufactured for the Light Water Breeder Reactor, to ensure that the rods were loaded with the correct fuel pellet arrangement and that other rod dimensional attributes were correct for each rod type. These evaluations were made on in-motion x-ray radio-graphs taken of each fuel rod. Because pellets of each fuel enrichment were made to a unique geometry (length and diameter), they could be radiographically checked to ensure that they were in the correct locaions. After each rod was radiographed, the length and diameter of each pellet shown on the radiograph was measured and the results compared to predetermined limits. The external rod attributes were also similarly checked during this measurement to ensure that all attributes were correct for each rod type.

40852 (WAPD-TM—1228) **Ultrasonic testing of nuclear fuel rod welds and clad (LWBR Development Program).** Dickerson, P.M. (Bettis Atomic Power Lab., West Mifflin, PA (USA)). Feb 1979. Contract EY-76-C-11-0014. 42p. Dep. NTIS, PC A03/MF A01.

Ultrasonic techniques were developed utilizing commercially available equipment as a part of the work required in the LWBR Core Manufacturing program for assurance of fuel rod weld integrity and for measurement of fuel rod clad thickness and clad thickness eccentricity. The need for the highest possible resolution and the undesirability of transducer to rod contact dictated the use of a water immersion technique with pulse-echo instrumentation for both weld and clad thickness ultrasonic tests. For the weld test, both longitudinal wave and shear wave inspections were employed with the transducers shuttled together back and forth longitudinally across the weld zone as the fuel rod was rotated. For the clad thickness test, only the longitudinal wave inspection was used with a helical scan pattern along the full length of the clad.

40853 (WAPD-TM—1272) **Sources of internal hydriding in unirradiated thoria-fueled Zircaloy rods (LWBR Development Program).** Clayton, J.C. (Bettis Atomic Power Lab., West Mifflin, PA (USA)). Feb 1979. Contract EY-76-C-11-0014. 58p. Dep. NTIS, PC A04/MF A01.

The low-temperature ($\leqq$ 550°C), low-pressure ($\leqq$ 36 torr) hydrogen absorption characteristics of specific types of Zircaloy-4 internal cladding surfaces (pickled, machined and welded) were investigated. The highest hydrogen contents were found at the machined and abraded surfaces. Although the pickled surface film on Zircaloy-4 retarded hydrogen pickup, especially at lower temperatures ($\leqq$ 400°C) and very low hydrogen pressures ($\leqq$ 3.5 torr), some hydrogen was absorbed through the film even under these conditions. More hydrogen penetrated the pickled surfaces at higher temperatures and pressures. The pickled surfaces absorbed the hydrogen uniformly and without localization even with some film imperfections present. Little hydriding occurred when etched and welded Zircaloy-4 surfaces were exposed to water vapor at corrosion temperatures.

40854 (WAPD-TM—1297) **Brazing of AM-350 stainless steel LWBR fuel rod support grids (LWBR Development Program).** Ebejer, L.P. (Bettis Atomic Power Lab., Pittsburgh, PA (USA)). Feb 1979. Contract EY-76-C-11-0014. 94p. Dep. NTIS, PC A05/MF A01.

A brazing process has been developed wherein several hundred stamped AM-350 stainless steel sheet metal components, wire components and machined bar components were simultaneously joined together to fabricate about 400 grids of different sizes for the LWBR fuel rod support system. High temperature (2110F +- 20F) vacuum brazing was employed using Ni—Cr—Si braze alloy filler metal in the form of paste. Techniques employed in the assembly, braze alloy application and fixturing of grids to achieve adequate dimensional control are discussed in detail. The brazing thermal cycle as related to the complex metallurgical process of both AM-350 stainless steel and the Ni—Cr—Si braze alloy is also discussed.

40855 (WARD-SD—3045-10) **High temperature structural design technology: application. Semiannual progress report for the the period ending September 30, 1977.** Griffin, D.S. (Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.). Mar 1979. Contract EY-76-C-02-3045-032. 216p. AT.

Progress in the development of high-temperature structural design methods for LMFBR components is reported in the following areas: design criteria and standards; simplified inelastic analysis methods; computer program validation and utilization; and piping integrity.

40856 Auxiliary cooling device for the primary fluid heat exchanger of a nuclear reactor. Pouderoux, P. (to Stein Industrie S.A.). US Patent 4,148,686. 10 Apr 1979. Priority date 18 Dec 1975, France, 4p.

An auxiliary cooling device for a primary fluid heat exchanger of a rapid neutron nuclear reactor is described, the exchanger having at least one nest of tubes in which there flows water to be heated to superheated steam and around whose tubes and inside whose casing there flows a liquid alkaline metal constituting the primary fluid. The casing of the exchanger is surrounded by a jacket having an air inlet tube and an air outlet tube at opposite ends. Inside the jacket there are auxiliary heat exchange surfaces such as spikes projecting from the casing of the primary heat exchanger proper. Application is to the absorption of residual power produced by a rapid neutron reactor after it is shut down.

40857 Microstructural aspects of nuclear fuel. Graham, R.A.; Rasmussen, D.E.; Carlson, M.C.J. pp 404-413 of Ceramic microstructures '76: with emphasis on energy related applications. Fulrath, R.M.; Pask, J.A. (eds.). Boulder, CO; Westview Press (1977).

From 6. international symposium - ceramic microstructures '76; Berkeley, CA, USA (24 Aug 1976).

Pore size distribution and morphology characterization data were obtained for a wide range of mixed oxide fuel microstructures and related to fabrication parameters. Fuel microhomogeneity is characterized as equivalent sized PuO_2 regions calculated from concentration dependent size distribution information. Techniques described can provide an effective basis for comparing and monitoring effectiveness of alternate fabrication techniques and definition of critical parameters.

40858 (HEDL-SA—1494) **Experimental evaluation of cell liners.** Wierman, R.W.; Simmons, L.D.; Muhlestein, L.D. (Hanford Engineering Development Lab., Richland, WA (USA)). [nd]. Contract EY-76-C-14-2170. 28p. Dep. NTIS, PC A03/MF A01.

Cell liners may be used in breeder reactor sodium pipe ways, sodium cells, and lower cavity region to provide a leak-tight cell and to protect the concrete from sodium in the unlikely event of a sodium spill. The objectives of the HEDL liner verification test program are to evaluate the integrity of liner concepts under postulated accident conditions and to develop the experimental data base which will demonstrate that liners will not fail. Two specific tests are reported; a high temperature liner feature test, and a large-scale liner sodium spill test. In both tests no failures of the liners or tendencies toward failure were detected. The discussed liner designs appeared to be conservative, and the liner strength appeared to be more than adequate.

POWER REACTORS, AUXILIARY, MOBILE, PACKAGE, AND TRANSPORTABLE

REFER ALSO TO CITATION(S) 40893

REGULATION AND LICENSING

REFER ALSO TO CITATION(S) 40846, 40921

40859 (INIS-mf—4600) **Ministerial Decree of 30 March 1978 on the exclusion of nuclear installations from the application of the requirements on combustion control.** (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1978. 1p. (In Italian). Dep. NTIS (US Sales Only), PC A02/MF A01.

This Decree was made by the Italian Minister for Industry, Commerce and Crafts; it lays down that nuclear installations governed by Act No. 1860 of 31 December 1962 on the Peaceful Uses of Nuclear Energy and by Presidential Decree No. 185 of 13 February 1964 on Radiation Protection and excluded from the scope of are Royal Order No. 824 of 12 May 1927 on combustion control.

40860 (INIS-mf—4616) **Regulation of the complete fuel cycle current and proposed nuclear legislation in Canada.** Boyd, F.C. (Atomic Energy Control Board, Ottawa, Ontario (Canada)). 1978.

7p. (CONF-780584—1). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on regulating nuclear energy; Brussels, Belgium (16 May 1978).

The increasing complexity of the Canadian nuclear programme, the problems of contamination and uranium mine safety and the national and international concern about proliferation have emphasized the need for a systematic and strong control over nuclear activities. Although the 1946 Atomic Energy Control Act provides the Atomic Energy Control Board with most of the powers necessary to achieve this, the new Act has been introduced to clarify jurisdiction and to strengthen the Board, which would then be renamed the Nuclear Control Board. Its duty would be to control health, safety and the environmental and other security aspects of the complete fuel cycle.

40861 (INIS-mf—4617) **Treatment of differing professional opinions in the regulatory review process.** Shapar, H.K. (Nuclear Regulatory Commission, Washington, DC (USA)). 1978. 7p. (CONF-780584—9). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on regulating nuclear energy; Brussels, Belgium (16 May 1978).

The Nuclear Regulatory Commission is an independent body whose purpose is to assure that civilian nuclear activities are consistent with the public health and safety and environmental protection. To this effect, Congress has vested it with the necessary control powers. The question here is how to reconcile diverging opinions expressed within NRC by executives and technicians during the enquiry pocedure for licensing of nuclear installations. The diversity of professional viewpoints should be viewed as a positive factor strengthening the regulatory process and should therefore be maintained. However, decisions must be made; therefore some viewpoints will not prevail but that should not be construed as a signal that the internal discussion process is condemned. NRC staff are entitled to express their views and not subjected to professional and administrative sanctions for doing so.

40862 (INIS-mf—4618) **Impact of the nuclear critics on the development of the regulating process.** Roser, T. (Oskarshamnsverkets Kraftgrupp AB, Stockholm (Sweden)). 1978. 13p. (CONF-780584—7). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on regulating nuclear energy; Brussels, Belgium (16 May 1978).

The impact of nuclear critics on the regulating process is difficult to analyse as the question is to identify them and to define their aim. In the United States it is generally considered that such critics are the new class of liberal intellectuals who have been politically jolted by Vietnam and Watergate. On this side of the Atlantic, the anti-nuclear movement seems different, less coherent and more complex: the local opposition, the environmentalists and the militant radicals. All these opponents can intervene at three levels: technically they attack the technical standards applied and propose other energy sources. At regulatory level they can influence decision-making provided they are in a majority; politically they take action on behalf of the basic respect of democracy for minorities and individual rights.

40863 (INIS-mf—4619) **Consequences of new Swedish legislation on operating licenses.** Gimstedt, O. (Oskarshamnsverkets Kraftgrupp AB, Stockholm (Sweden)). 1978. 18p. (CONF-780584—5). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on regulating nuclear energy; Brussels, Belgium (16 May 1978).

The new Swedish Act of 1977 introduced the requirement for a special permit for loading nuclear reactors with fuel. The author, in addition to analysing the Act, recalls the practical context within which it was adopted and examines in detail the measures to be taken by operators to meet these new requirements. The most important one concerns the method and the means for disposing of the radioactive waste produced by nuclear power plants.

40864 (INIS-mf—4621) **Congressional impact on reactor regulation.** Price, H.S. (Atomic Industrial Forum, Inc., New York (USA)). 1978. 13p. (CONF-780584—6). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on regulating nuclear energy; Brussels, Belgium (16 May 1978).

Congress can stimulate the nuclear option in two ways. First, the chairmen of parliamentary committees and subcommittees whose role is determining and in general the elected bodies who support the nuclear development program as an integral part of the national energy policy. They can dispel doubts and the ambiguous climate in which decision makers in the Executive Branch, the Judiciary of the State and Local Governments now operate, by affirming that the Atomic Energy Act is an expression of the national will. Secondly, Congress can create an effective vehicle for accelerating the licensing procedure for nuclear installations. The Administration's recently proposed Bill on the subject will enable Congress to set up a simplified and hence speedier system.

40865 (INIS-mf—4622) **Hurdles to regulatory reform: a former regulator's view.** Rowden, M.A. (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1978. 10p. (CONF-780584—8). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on regulating nuclear energy; Brussels, Belgium (16 May 1978).

The present paper reviews the numerous obstacles which should be overcome by reforming the regulations on nuclear installations; dual responsibilities of Federal and State Agencies, duplication of tasks entrusted to different Federal Agencies such as EPA and NRC. The sensitivity of public opinion towards nuclear decisions and political interferences are the source of other difficulties. The new Non-proliferation Act and the Licensing Reform Bill are analysed in the light of these considerations. In conclusion, the importance of the recent Supreme Court decision in the Vermont Yankee and Midland cases is emphasized in this context.

40866 (INIS-mf—4624) **Stability in licensing requirements: a technical perspective.** Szalay, R.A. (Atomic Industrial Forum, Inc., New York (USA)). 1978. 14p. (CONF-780584—11). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on regulating nuclear energy; Brussels, Belgium (16 May 1978).

The serious difficulties encountered in the licensing procedure for nuclear power plants in the United States have resulted in the elaboration of a Bill on the siting and licensing of nuclear installations for the purpose of reforming the present system. The author fears, however, that this Bill will not reduce the complexity of present regulations and will be unable to reach the object sought which is to reduce the length of the procedure; he analyses the technical and political reasons underlying this situation, and in particular the role of the staff of the Nuclear Regulatory Commission.

40867 (INIS-mf—4626) **Regulatory practices and standards: the international scene and trends.** Vinck, W.; Essler, W.; Maurer, H.A.; van Reijen, G. (Commission of the European Communities, Brussels (Belgium)). 1978. 37p. (CONF-780584—12). Dep. NTIS (US Sales Only), PC A03/MF A01.

From International conference on regulating nuclear energy; Brussels, Belgium (16 May 1978).

At national level, codification of standards governing the licensing and operation of nuclear installations is very different, ranging from criteria to regulations, according to the degree of the obligation imposed by national authorities; it also reflects the variety of national situations and the peculiarities of the legal and political systems. The need to agree upon a level of nuclear safety which is generally recognised as satisfactory and to exchange scientific and technological information in this field has greatly stimulated international co-operation, in particular within the framework of specialized international organisations such as IAEA, ISO, Euratom and OECD/NEA. Harmonization of such standards is particularly important from the viewpoint of public opinion in the countries concerned. In addition, the intrinsic safety of nuclear power plants, assurances as to the duration of plant life should increasingly be highlighted in future.

40868 (INIS-mf—4629) **Export policy and non-proliferation.** Fischer, D.A.V. (International Atomic Energy Agency, Vienna (Austria)). 1978. 6p. (CONF-780584—17). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on regulating nuclear energy; Brussels, Belgium (16 May 1978).

Developing countries with a nuclear programme are about a dozen according to information obtained by IAEA. They are a group hostile to any restriction imposed on nuclear technology export and consider that such restriction is contrary to the global concept of North/South co-operation which provides for transfer of advanced technology. In particular, they object to the fact that nuclear weapon states make use of Article 4 of the NPT. Industrialised countries are required to keep a balance between a regular and stable supply system and the assurance that exported nuclear installations and materials are placed under international control according to the IAEA Safeguards.

40869 (INIS-mf—4631) **Nuclear export policy and regulation for non-proliferation: Federal Republic of Germany.** Boulanger, W. (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1978. 8p. (CONF-780584—16). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on regulating nuclear energy; Brussels, Belgium (16 May 1978).

The nuclear export policy of the Federal Republic of Germany complies with the principle of non-proliferation of nuclear

weapons. Already in 1967 the Federal Government stated in a Peace Note that no export was authorised to countries (outside Euratom) which did not comply with the IAEA Safeguards. In the bilateral agreement the Federal Republic signed with Brasil in 1975, emphasis was put on international safeguards and the control exercised on exported materials to avoid any diversion for military purposes. (NEA).

40870 (INIS-mf—4633) **United States non-proliferation policy.** Kennedy, R.T. (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1978. 11p. (In French). (CONF-780584—18). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on regulating nuclear energy; Brussels, Belgium (16 May 1978).

The 1978 Act on Non-Proliferation reflects the new orientations of the U.S. energy policy. This policy is based on six objectives: optimization of the efficiency of the international safeguards system by insisting on the comprehensive and detailed character of such safeguards; moderation in transfer of sensitive technologies and materials enabling weapons' manufacture; encouragement of non-proliferation by assuring fuel supply and by assisting in irradiated fuel management; achievement of a consensus on the structure and management for the future of the nuclear fuel cycle in the frame of work conducted during the International Fuel Cycle Evaluation; adoption of internal measures ensuring compatibility of the national nuclear policy with international objectives; concrete action to diminish any reasons of prestige or safety that might induce states to manufacture nuclear explosives. (NEA).

40871 (NTISUB/B/201—005-R5) **Standard Review plan for the review of safety analysis reports for nuclear power plants, Revision No. 1 to Section 5.4.2.1.** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation). Nov 1978. 11p. NTIS PC A02.

Revision No. 1 to Section 5.4.2.1 of the Standard Review Plan incorporates changes that have been developed since the original issuance in September 1975, many of which are editorial in nature, to reflect current staff practice in the review of safety analysis reports for nuclear power plants.

40872 (NTISUB/D/142—012) **Nuclear Regulatory Commission issuances.** (Nuclear Regulatory Commission, Washington, DC (USA)). Dec 1978. 110p. NTIS $6.25.

Issuances received from the U.S. Nuclear Regulatory Commission, the Atomic Safety and Licensing Appeal Boards, and the Atomic Safety and Licensing Boards are presented.

40873 (PB—288392) **Licensee performance evaluation. Phase 1 technical report, November 1977—August 1978.** Chakoff, H.E.; Speaker, D.M.; Thompson, S.R.; Cohen, S.C. (Teknekron, Inc., Washington, DC (USA)). Oct 1978. Contract NRC-05-78-302. 207p. NTIS PC A10/MF A01.

The report documents a methodology that NRC may use to evaluate the regulatory performance of its licensees. The purpose of such an evaluation is to permit NRC to identify those licensees whose regulatory performance is marginal. The methodology proposed in this report emphasizes the detailed analysis of the content and trends in Licensee Event Reports (LERs) submitted by licensees. In principle, the methodology can be applied to any class of NRC licensees; however, performance data is relatively sparse for licensee classes other than operating power reactors. Case studies applying the methodology to the examination of three operating power reactor licensees in NRC's Region III suggests that the methodology may permit NRC to identify repetitive, or casually-linked, events that can be attributed to licensee human error. This information will allow NRC to deal with licensees and regulatory problems in a uniform, consistent, and timely manner; permit more effective and efficient use of NRC inspection resources; and provide better feedback to licensees to facilitate their self-improvement efforts. The three case studies tend to confirm previously suspected differences in the regulatory performance of the three licensees.

ECONOMICS

40874 (PB—287407) **Evaluation of uncertainties in benefit-cost studies of electrical power plants. II. Development and application of a procedure for quantifying environmental uncertainties of a nuclear power plant. Final report.** Sullivan, W.G. (Tennessee Univ., Knoxville (USA). Dept. of Industrial Engineering). Jul 1977. 177p. NTIS PC A09/MF A01.

Steam-electric generation plants are evaluated on a benefit-cost basis. Non-economic factors in the development and application of a procedure for quantifying environmental uncertainties of a nuclear power plant are discussed. By comparing monetary costs of a particular power plant assessed in Part 1 with non-monetary values arrived at in Part 2 and using an evaluation procedure developed in this study, a proposed power plant can be selected as a preferred alternative. This procedure enables policymakers to identify the incremental advantages and disadvantages of different power plants in view of their geographic locations. The report presents the evaluation procedure on a task by task basis and shows how it can be applied to a particular power plant. Because of the lack of objective data, it draws heavily on subjectively-derived inputs of individuals who are knowledgeable about the plant being investigated. An abbreviated study at another power plant demonstrated the transferability of the general evaluation procedure. Included in the appendices are techniques for developing scoring functions and a user's manual for the Fortran IV Program.

40875 **Productivity assessment of nuclear generation systems.** Lapides, M.E. (Electric Power Research Inst., Palo Alto, CA). pp 191-218 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

Selection of programs to improve the productivity of generating units has been a concern of the Electric Power Research Institute (EPRI) since its inception. The process in use emphasizes direct communications between the Institute, its sponsoring utilities, and equipment suppliers, supplemented by analytical methods for program selection. The analyses, based on modeling of operating experience, illustrate the potential value of formal reliability analyses for individual generating units and for selecting productivity improvement R and D programs. This paper summarizes the status and future of these analytical assessments.

FUEL CYCLE

REFER ALSO TO CITATION(S) 40836

NUCLEAR REACTOR TECHNOLOGY

THEORY AND CALCULATION

REFER ALSO TO CITATION(S) 40381

40876 (LA-UR—79-483) **Modeling of large pressurized water reactors.** Liles, D.R.; Mahaffy, J.H. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 22p. (CONF-790326—1). Dep. NTIS, PC A02/MF A01.

From Conference on basis two-phase flow modeling in reactor safety and performance; Tampa, FL, USA (2 Mar 1979).

The TRAC (Transient Reactor Analysis Code) program is an advanced computer code which is designed to model postulated accidents in light water reactors. The paper discusses some of the methodology employed in modeling large internal flow systems. Emphasis is placed on the numerical and modeling problems inherent in computer codes.

40877 (UCID—18168) **Calculation of laminar incompressible fluid flow and heat transfer during spherical annulus filling.** Tuft, D.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Apr 1979. Contract W-7405-ENG-48. 87p. Dep. NTIS, PC A05/MF A01.

A method of computing laminar incompressible fluid-flow and heat transfer during the filling of a spherical annulus is presented. Transient fluid temperatures and heat flux rates in the spherical annulus are calculated for an insulated outer sphere and a constant temperature inner sphere with heated water filling the annulus from the bottom. To achieve a solution, laminar axially symmetric flow is assumed and the Marker-and-Cell (MAC) free surface computational method is applied to this problem in spherical coordinates. Changes in the standard MAC treatment are incorporated and special methods for handling the free surface are introduced. A variable mesh is used to improve resolution near the inner sphere where temperature and velocity gradients are steep and the governing equations are derived for variable fluid properties to allow an eddy viscosity turbulence model to be applied later. Calculations of velocity, temperature, and inner sphere heat flux in a spherical annulus of 139.7 mm inner radius, and 168.3 mm outer radius within an inlet tube diameter of 38.1 mm are presented.

COMPONENTS AND ACCESSORIES

REFER ALSO TO CITATION(S) 40794, 41220, 41221, 41226, 41273, 41276, 41287, 41288, 41757

40878 (AED-Conf—78-048-004) **Quality assurance in the nuclear industry.** Knoedler, D. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1978. 27p. (In German). (CONF-780246—4). Dep. NTIS (US Sales Only), PC A03/MF A01.

From International symposium on quality assurance; Bad Neuenahr, F.R. Germany (27 Feb 1978).

Quality assurance is the sum of all activities systematically planned, practiced, and controlled with the aim to assure the quality of deliveries and performances. This assurance today covers all phases of activities, from the planning (including a determination of the required and necessary quality characteristics) to the start-up of a plant.

40879 (CONF-770807—Pt.F, pp vp) **Improved procedures for pipe rupture analysis.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

40880 (CONF-770807—Pt.F, pp vp) **Local crush rigidity of pipes and elbows.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

An experimental and theoretical study was conducted to determine the quasi-static local crush stiffness of piping. Applications include the evaluation of displacement limiting bumpers, low velocity impacts and a novel energy absorbing restraint. The experiments provided force-deflection curves and scaling laws for several configurations. The scaling law for the simplest geometry, a ring, was compared to computer evaluations and proved acceptable well beyond the range of experiment. This comparison also justifies analytical techniques for investigating variability due to material, temperature, internal pressure, and loading geometry. The crush geometries were chosen to represent basic geometries, typical pipe configurations, or proposed restraint designs, which could be conveniently tested in a hydraulic press: straight section of pipe between parallel flat plates, straight sections of pipe supported on a flat plate and indented by either a solid section or pipe whose axis is perpendicular to the axis of the crushed pipe, the extrados surface of an elbow against a plate. The force deformation characteristics obey simple scaling laws which parametrically employ wall thickness and pipe radius expressed to singular powers for each geometry. Since the indentor crush force has a relatively flat plateau over a long crush stroke, it forms an efficient load-limiting pipe rupture restraint. The effect of diameter relative to the impacting process pipe is small within the range of 2:1. The ends of the bumper pipe ovalize for a length/diameter ratio of three. Beyond 1 1/4 diameters from the center of the crushed zone, the bumpers pipe lifts off the bearing surface. The elbow crush stiffness is insensitive to boundary conditions for small deformations.

40881 (CONF-770807—Pt.L, pp vp) **High temperature fatigue experiments on welded stainless steel tubular elements.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A test rig has been designed to perform high temperature fatigue experiments on AISI 304 stainless steel tubular elements of 500 mm length, 60.3 mm outer diameter and 2 mm thickness; they are composed by two butt welded tubular elements with welded end flanges. During the experiments it is possible to control the axial strain range, the strain rate and the hold time; the specimen temperature is obtained by an inner heating device, controlled by a series of measuring thermocouples; until now the imposed temperature is 650°C. A preliminary series of experiments has been carried out, with the aim at getting informations for a proper development of the main experimental program, while in the meantime the adjustment of the specimen manufacturing process and its characterization have been performed. Each specimen is welded on the same TIG welding rig, which accounts both for a uniformly reliable welding process and for a proper alignment of the tubular elements. The specimens are then marked by a high precision grid which allows a measurement of the residual localized plastic strain along some generatrix of the specimen and on its thickness. The basic fatigue data have to be measured through a series of standard tests carried out on small size specimens obtained either from the base material and around the welded, heat affected zone. It is also planned to carry out a detailed study on the crack surfaces and to use acoustical emission techniques to properly assess the initial crack propagation. The first results show a marked reduction of the number of cycles at failure, if compared with existing data about small size specimens; the measurement of residual plastic strains shows clearly non-uniform distribution of the plastic zones.

40882 (CONF-770807—Pt.L, pp vp) **Plasticity formulation for cyclic inelastic structural analysis.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

40883 (CONF-780819—P1, pp 428-436) **Operational maintenance problems with iodine adsorbers in nuclear power plant service.** Graves, C.E.; Hunt, J.R.; Jacox, J.W.; Kovach, J.L. (Nuclear Consulting Services, Inc., Columbus, OH). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

The start-up and inservice testing of adsorber systems and components and their maintenance show several problems which can be prevented by change in design, installation and operation procedures.

40884 (CONF-780819—P2, pp 871-892) **Performance evaluation of an 18,000 CFM fill-in-place adsorber unit.** Porco, R.D. (Mine Safety Appliances Co., Evans City, PA). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Under a commercial contract MSA was required to assemble and factory test a complete 18,000 CFM air filtration train before shipment to the plant site. The filter train tested was approximately 14 ft. wide by 9 ft. high by 31 ft. long and weighed an estimated 33,500 pounds. It contained four stages of filtration - moisture separators (prefilters are substituted for this test), upstream and downstream HEPA filters and a Type III (Fill-In-Place) Sorber. Filter train design followed the guidelines set forth by ANSI N509-1976 and the tests were conducted under factory controlled conditions per ANSI N510-1975. In addition to the ANSI N510 tests, an extensive program was conducted to determine slot velocities, bed packing density, bed flow distribution, and effect of filling methods on particle size and sorber performance for the Type III High Efficiency Sorber. The purpose of the testing was to demonstrate that after filling, the Type III sorber will function as designed for contaminant removal and thereby qualifying the fill method and Type III sorber design. Additional criteria were to develop and establish suitable testing procedures which can be implemented to demonstrate functional performance on any Type III sorber unit.

40885 (CONF-7809114—1) **Evaluations of half-bead weld repair procedures with thick-wall pressure vessels.** Canonico, D.A.; Whitman, G.D. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 6p. Dep. NTIS, PC A02/MF A01.

From 3. international symposium of the Japan Welding Society on Criteria for Preventing service failure in Welded Structures; Tokyo, Japan (26 Sep 1978).

The results of research on the evaluation of the half-bead weld repair method for use on nuclear reactor components are reviewed from data obtained on thick-section test pieces and intermediate-size pressure vessels. Material properties, the magnitude of residual stresses and the structural behavior of flawed pressure vessels are being obtained to determine the adequacy of the weld repair method for application in thick-section components.

40886 (NUREG/CR—0703) **Inspection of nuclear reactor welding by acoustic emission. Progress report, November 1977—November 1978.** Prine, D.W.; Mathieson, T.A. (GARD, Inc., Niles, IL (USA)). Feb 1979. 68p. NTIS, PC A04/MF A01.

This report covers work in the first phase of a two phase program aimed at extending the capability of in-process acoustic emission monitoring of nuclear fabrication welds from flaw detection and location to flaw characterization in terms of type and size. During this first phase, previously acquired AE data from laboratory and shop nuclear fabrication welds were analyzed and computer subroutines were developed that would automatically determine flaw type and size. After optimization on this large bank of recorded AE data the best models were tested on both live laboratory welding and actual shop welds. The results of these tests were very encouraging and indicate that in-process acoustic emission monitoring can provide useful information as to flaw size and type. This reported work was accomplished using a GARD-developed microprocessor-based AE analyzer.

40887 **Drum of storing fuel assemblies of nuclear reactor.** Artemiev, L.N.; Batjukov, V.I.; Fadeev, A.I. US Patent 4,149,087. 10 Apr 1979. Filed date 13 May 1977. 4p.

The proposed drum for storing fuel assemblies of a nuclear reactor comprises a holder rotatable around its axis and provided with tubular sockets arranged in concentric rows along the circumference of the holder so that the axis of at least one socket of each row intersects the trajectory described by the grip of the recharging mechanism in the course of its movement. The proposed drum design makes it possible to facilitate and speed up the process of recharging fuel asemblies.

40888 Use of the acoustical emission method in reactor material science studies. Perevezentsev, V.N.; Itkin, A.S.; Kryukov, A.M. pp 144-156 of Radiatsionnye effekty izmeneniya mekhanicheskikh svoisty konstruktsionnykh materialov i metody ikh issledovaniya. Pisarenko, G.S. (ed.). Kiev, USSR; Izdatel'stvo Naukova Dumka (1977). (In Russian)

From 2. All-Union conference on the radiation effects of the change in the mechanical properties of construction materials and methods of investigating them; Kiev, USSR (Apr 1976).

A short history is given on the development of works on the use of acoustical emission (AE) in material science studies, and an examination is made of the physical bases for the emergence of AE in materials under stress, and certain experimental results on the study of acoustical emission in various materials. The various areas for the practical use of the AE method in reactor material science studies are indicated. 15 references, 6 figures.

FUEL ELEMENTS

REFER ALSO TO CITATION(S) 41285, 41298, 41302, 41329

40889 (CONF-770807—Pt.L, pp vp) **Plastic instability criteria for necking of bars and ballooning of tubes.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Plastic-instability criteria applicable to the necking of bars under tension and to the ballooning of thin-wall tubes under internal pressure were derived from basic geometrical considerations. In the case of bars under tension, plastic instability prevails if the percentage rate of decrease of the cross-sectional area in the (potential) necking region is greater than that in the bulk of the bar. When the loading characteristics and constitutive equation were taken into account, an instability criterion was deduced in terms of the stress, strain, strain rate, temperature and material properties. This criterion was shown to be reducible to the classical Considere condition for non-rate-sensitive materials. For rate-sensitive materials under isothermal conditions, a simple relationship among the strain, the strain-hardening and strain-rate-sensitivity parameters was also obtained. In the case of thin-wall tubes under internal pressure (with or without imposed axial loading), plastic instability prevails if the percentage rate of increase of the diameter (or equivalently decrease of wall thickness) in the (potential) ballooning region is greater than that in the bulk of the tube. An instability criterion in terms of the axial strain rate and the axial derivatives of the hoop strain and hoop strain rate was first deduced. Then the loading characteristics, the constitutive equation, the thin-wall approximation, and the Prandtl-Reuss flow rules were taken into consideration. This resulted in a further statement of the criterion in terms of the state of strain, the material properties, and a ratio of the imposed axial stress to the circumferential stress. As in the case of necking of bars, the role of the hardening parameter is clear: i.e., a larger hardening parameter implies a more stable material and vice versa.

40890 Method for savings in nuclear reactors by using beryllium rods in fuel bundles. Chien, J.P.; Yang, C.Y.; Hsich, H.M. (to Institute of Nuclear Energy Research). US Patent 4,148,687. 10 Apr 1979. Filed date 26 Aug 1976. 4p.

Nuclear fuels in the form of rod bundle with one or several beryllium rods inserted therin are proposed for use in power reactors positioned to obtain reactivity increase in order to save the D_2O inventory in a heavy water reactor or to relax the requirement of uranium enrichment if used in light water reactors.

40891 Microstructures of as-fabricated UO_2 fuel pellets. Davis, H.H.; Ferrell, L.J. (Babcock and Wilcox Co., Lynchburg, VA). pp 389-403 of Ceramic microstructures '76: with emphasis on energy related applications. Fulrath, R.M.; Pask, J.A. (eds.). Boulder, CO; Westview Press (1977).

From 6. international symposium - ceramic microstructures '76; Berkeley, CA, USA (24 Aug 1976).

Uranium dioxide fuel pellets are prepared by cold pressing and sintering to about 92 to 95% theoretical density. The wide range of material and fabrication variables available results in numerous microstructural types being produced. This paper will correlate microstructural characteristics of as-fabricated UO_2 pellets to the individual processing variables, with particular emphasis being placed on porosity morphologies.

40892 Effect of changes in the mechanical properties of construction materials exposed to irradiation on the efficiency of the active zone elements in fast energy reactors. Likhachev, Yu.I.; Proshkin, A.A.; Popov, V.V.; Tuzov, A.N. pp 45-59 of Radiatsionnye effekty izmeneniya mekhanicheskikh svoisty konstruktsionnykh materialov i metody ikh issledovaniya. Pisarenko, G.S. (ed.). Kiev, USSR; Izdatel'stvo Naukova Dumka (1977). (In Russian)

From 2. All-Union conference on the radiation effects of the change in the mechanical properties of construction materials and methods of investigating them; Kiev, USSR (Apr 1976).

A need is shown for an intensive study of the intra-reactor durability characteristics of construction materials of nuclear reactor fuel elements for reliably predicting their efficiency. Note is taken of the importance of using statistical approaches for evaluating the efficiency of the active zone as a whole. A method is proposed for studying the radiative creep of material in the fuel elements' casing at high stress levels. 28 references, 4 illustrations.

CONTROL SYSTEMS

40893 Control for nuclear thermionic power source. Sawyer, C.D. US Patent 4,085,004. 18 Apr 1978. Filed date 21 Nov 1975. 9p.

A control for a power source which includes nuclear fuel interspersed with thermionic converters, is described. A power regulator maintains a substantially constant output voltage to a variable load, and a control circuit drives a neutron flux regulator in accordance with the current supplied to the power regulator and the neutron flux density in the region of the converters. The control circuit generates a control signal which is the difference between the neutron flux density and a linear function of the current, and drives the neutron regulator in a direction to decrease or increase the neutron flux according to the polarity of the control signal.

40894 Process and apparatus for shutdown and control of a gas-cooled nuclear reactor. Brandes, S. (to Hochtemperatur-Reaktorbau GmbH). US Patent 4,148,685. 10 Apr 1979. Priority date 23 Mar 1976, German, Federal Republic of (F.R. Germany), 10p.

Disclosed are a method and apparatus for regulating and shutting down a gas cooled nuclear reactor having a bed of spherical fuel elements, wherein regulation of the reactor is accomplished by a first set of absorber rods in the side reflector of the reactor, partial shutdown is achieved by a second set of absorber rods movable in the top reflector and in the space above the fuel elements, and total shutdown is accomplished by a third independent set of absorber rods which can be moved downwardly into the fuel elements.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 40448

40895 (UCLA—34P252-02) **Evaluation of the incremental seismic risk due to the presence of nuclear power plants.** Lee, Y.T.; Okrent, D.; Apostolakis, G. (California Univ., Los Angeles (USA). Dept. of Chemical, Nuclear, and Thermal Engineering). Dec 1978. Contract EY-76-S-03-0034-252. 42p. Dep. NTIS, PC A03/MF A01.

The seismic risk for the continental United States, in terms of the expected annual number of deaths and severe injuries, and the expected property damage, is evaluated in this work. Probabilistic models and correlations are developed and used in the evaluations of the risks, accounting for such important variables as the variability of property values, damage factors, and so on. In addition, the incremental seismic risk due to the presence of nuclear power plants is evaluated utilizing results and methods available in the literature. The results show that the incremental risk is generally very small compared to the background seismic risk, even if a very high probability for core melt is postulated.

RADIOACTIVE EFFLUENTS

REFER ALSO TO CITATION(S) 40449

40896 (CONF-780819—P1, pp 208-230) **Monitoring and removal of gaseous carbon-14 species.** Kabat, M.J. (Ontario Hydro, Toronto, Canada). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

A simple and efficient method was developed for the monitoring of low level carbon-14 in nuclear power station areas and gaseous effluent. Gaseous carbon compounds (hydrocarbons and

CO) are catalytically oxidized to CO_2, which is then absorbed on solid $Ca(OH)_2$ at elevated temperatures. The ^{14}C collected is quantitatively liberated by thermal decomposition of $CaCO_3$ as CO_2, which is either measured directly by flow-through detectors or absorbed in alkali hydroxide followed by liquid scintillation counting. The method can also be used for the removal of gaseous ^{14}C. The $Ca^{14}CO_3$ can be immobilized in concrete for long term disposal. $Ca(OH)_2$ is an inexpensive absorber. It is selective for CO_2 and has high capacity and efficiency for its absorption and retention. A theoretical evaluation of thee optium conditions for CO_2 absorption and liberation is discussed and experimental investigations are described. There is good agreement between theoretical predictions and experimental findings.

40897 (CONF-780819—P1, pp 446-475) **Determination of the physico-chemical ^{131}I species in the exhausts and stack effluent of a PWR power plant.** Deuber, H.; Wilhelm, J.G. (Dernforschungszentrum Karlsruhe GmbH, Germany). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

To quantify the credit that can be granted in the assessment of the ^{131}I ingestion doses and the improvement that can be achieved in the ventilation systems if differences of the physico-chemical ^{131}I species with respect to the environmental impact are taken into account, the fractions of the ^{131}I species were determined in the stack effluent and in various exhausts of a 1300 MW/sub e/ PWR power plant during a period of 3 months. Based on these measurements, calculations for different cases of filtration of the main exhausts for iodine were carried out. The average fractions of elemental and organic ^{131}I were about 70 and 30% respectively in the stack effluent during the time indicated. Elem. ^{131}I orginated mainly from the hoods in which samples of the primary coolant are taken and processed. Org. ^{131}I was mainly contributed by the equipment compartments. If the hood exhaust had been filtered, as was the case with the equipment compartment exhaust, the fractions of elem. and org. ^{131}I would have been on the order of 50% each and the calculated ^{131}I ingestion doses would have been a factor of 3 lower.

40898 (EGG—1183-1701) **Aerial radiological survey of the areas surrounding the Big Rock Point nuclear plant, Big Rock Point, Michigan. September 1975.** (EG and G, Inc., Las Vegas, NV (USA)). Jan 1977. Contract EY-76-C-08-1183. 21p. Dep. NTIS, PC A02/MF A01.

An airborne radiological survey of a 1080 km^2 area surrounding the Big Rock Point Nuclear Plant was made on 6 September 1975. Detected radioisotopes and their associated gamma ray exposure rates were consistent with that expected from the normal background emitters. The plant stack release plume was encountered; radionuclides found were typical of the fission products of such releases. Aerial average exposure rates equivalent to one meter above the ground are presented in the form of an isopleth map. Exposure rates measured with small portable instruments and soil sample analysis differed somewhat from the airborne data due to soil moisture differences between the time aerial and ground measurements were taken. Geological data are presented in an isopleth map of rock and soil types; a brief description of the vegetation and terrain surrounding the site is also attached.

40899 (EGG—1183-1720) **Aerial radiological survey of the area surrounding the LaCrosse Boiling Water Reactor site, Genoa, Wiconsin. June 1976.** Boyns, P.K. (EG and G, Inc., Las Vegas, NV (USA)). Oct 1977. Contract EY-76-C-08-1183. 18p. Dep. NTIS, PC A02/MF A01.

An airborne radiological survey of an 2146-km^2 area surrounding the LaCrosse Boiling Water Reactor site was made between June 20—22, 1976. Detected radioisotopes and their associated gamma ray exposure rates were consistent with that expected from the normal background emitters. Aerial average exposure rates equivalent to one meter above the ground are presented in the form of an isopleth map. Exposure rates measured with small portable instruments and soil sample analysis showed excellent agreement with the airborne data. Geological data are presented in an isopleth map of rock and soil types; a brief description of the vegetation and terrain surrounding the site is also included.

CHEMICAL AND THERMAL EFFLUENTS

REFER ALSO TO CITATION(S) 41705, 41757, 41762

RESEARCH, TEST, AND EXPERIMENTAL REACTORS

REFER ALSO TO CITATION(S) 40843, 40938, 40940, 40944, 40947, 40950, 40951, 40965, 40982

40900 (CONF-790441—2) **LOFT nuclear fuel rod behavior.** Niebruegge, D.A.; Tolman, E.L. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 4p. Dep. NTIS, PC A02/MF A01.

From ANS topical meeting on light water reactor fuel performance; Portland, OR, USA (29 Apr 1979).

An overview of the calculational models used to predict fuel rod response for Loss-of-Fluid Test (LOFT) data from the first LOFT nuclear test is presented and discussed and a comparison of predictions with experimental data is made.

40901 (CONF-790602—15) **LOFT reactor advanced instrumented center fuel bundle.** Howell, T.E.; Selcho, H.S. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 6p. Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; Atlanta, GA, USA (3 Jun 1979).

The program for designing and fabricating replacement fuel modules for LOFT provides a method for incorporating improvements in contemporary LPWR fuel design and in-reactor measurement techniques. Special development projects for measurement devices support the LOFT replacement fuel program.

40902 (CONF-790602—17) **LOFT fuel design and operating experience.** Russell, M.L. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 4p. Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; Atlanta, GA, USA (3 Jun 1979).

The objective of the LOFT fuel design and fabrication effort was to provide a pressurized water reactor core that has (1) materials and geometric features to ensure that heat transfer, hydraulic, mechanical, chemical, metallurgical and nuclear behaviors are typical of large pressurized water reactors (PWR) during the loss-of-coolant accident (LOCA) sequence and (2) test instrumentation for measurement of core conditions. The LOFT core is unique because it is designed for exposure to several LOCAs without loss of function. This paper summarizes the design effort and extent to which the design objectives have been achieved.

40903 (CONF-790602—26) **Unique features of the LOFT startup program.** Cannon, J.W.; Peters, M.D. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 3p. Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; Atlanta, GA, USA (3 Jun 1979).

The unique character of the LOFT reactor provided an excellent opportunity to gain startup experience and develop new test methods. The reactor, operated by EG and G Idaho for the NRC, is a 1/55 scale model of a large commercial PWR, designed to test LOCA consequences and ECCS performance. The scaling, designed to simulate thermal hydraulic, linear heat, and flow conditions of a large PWR, and the use of an air-cooled condenser for removing heat from the secondary system presented a number of interesting physical variations from standard PWR conditions. The events described present an overview of the test methods and problems encountered during the startup program.

40904 (CONF-790615—7) **Third United States National Congress on pressure vessels and piping LOFT power range testing program.** Phoenix, W.C.; Stevenson, D.H. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 2p. Dep. NTIS, PC A02/MF A01.

From 3. US national congress on pressure vessels and piping; San Francisco, CA, USA (25 Jun 1979).

The Loss-of-Fluid Test (LOFT) Power Range Testing program brought the world's only large integral nuclear blowdown test facility from 0 to 100% power for the first time. The program was short, only 49 days from heatup to final scram. It was relatively trouble-free; the only significant problems were water hammers in the air-cooled condenser following scrams. The startup program, techniques for determining primary and secondary side natural circulation, and the water hammers are discussed.

40905 (LA—7675-MS) **JEZEBEL and GODIVA. Informal report.** Kidman, R.B. (Los Alamos Scientific Lab., NM (USA)). Feb 1979. Contract W-7405-ENG-36. 26p. Dep. NTIS, PC A03/MF A01.

Various code options and input data are tested in the calculation of the fast reactor benchmarks, JEZEBEL and GODIVA. Their effects on the eigenvalue and ^{238}U to ^{235}U central fission rate ratio are documented. Although the results can be used to improve past or future calculations, it appears that no reasonable choice of data or options can bring the calculated central fission ratio into agreement with the experimental value.

40906 (LTR—125-7) **LOFT cis analysis 4°-WH-237-E outside containment penetration S-17B.** Moha, J.E. (Idaho National Engineering Lab., Idaho Falls (USA)). 26 Mar 1979. Contract EY-76-C-07-1570. 57p. Dep. NTIS, MF/A01.

Portions of document are illegible.

A stress analysis was performed on the 4"-WH-237-E piping system outside containment penetration S-17B. Deadweight, thermal expansion, and seismic loads were considered. The results indicate that this piping will meet ASME Section III, Class 2 requirements.

40907 (LTR—141-96) **Theoretical basis of data analysis procedures for LOFT radiation: hardened gamma densitometer.** Lassahn, G.D. (Idaho National Engineering Lab., Idaho Falls (USA)). 22 Mar 1979. Contract EY-76-C-07-1570. 49p. Dep. NTIS, PC A03/MF A01.

The data analysis procedures for the LOFT Radiation-Hardened Gamma Densitometer are derived and descriued.

40908 (NUREG/CR—0646) **Computer program K-FIX/MOD1: a modification of the computer program K-FIX for applications to fluid flow simulation in LOFT system piping.** Demmie, P.N.; Hofmann, K.R. (Idaho National Engineering Lab., Idaho Falls (USA)). Mar 1979. Contract EY-76-C-07-1570. 98p. (TREE—1324). Dep. NTIS, PC A05/MF A01.

A description of the computer program K-FIX/MOD1 is given. K-FIX/MOD1 was developed as a multidimensional analytic tool based on a two-fluid model for applications to fluid flow simulation in Loss-of-Fluid Test (LOFT) system piping. The field equations that constitute the two-fluid model bases for K-FIX/MOD1 as well as the constitutive relations required to close this system of equations are presented and discussed. The finite difference equations that approximate these equations and their solution procedure are given. The global structure of K-FIX/MOD1 that implements this solution procedure is discussed. Finally, the input data for K-FIX/MOD1 and its preprocessor program PREP/MOD1 are given.

REACTOR SAFETY

REFER ALSO TO CITATION(S) 41776

40909 (ANL-RDP—79) **Reactor development program. Progress report.** (Argonne National Lab., IL (USA)). Jan 1979. Contract W-31-109-ENG-38. 136p. AT.

Progress is summarized in the following research and development areas: Experimental Breeder Reactor No. II (EBR-II) breeder-reactor design support, engineered systems and components, reactor physics, reactor safety, and other fast breeder reactors.

40910 (BF-R—62-968-1) **Status report on the conceivable outside pressure exerted on nuclear power stations by gaseous explosions.** Geiger, W. (Battelle-Institut e.V., Frankfurt am Main (Germany, F.R.)). 1977. 96p. (In German). Dep. NTIS (US Sales Only), PC A07/MF A01.

The following incidents to be taken into account in the whole process beginning with gas release and ending with a possible stress exerted on the power plant building are discussed in detail: Conditions leading to the release of large amounts of gas; formation of an explorable gas mixture cloud; ignition and course of explosion; pressure wave propagation in the surrounding air; construction dynamics and damaging effects. Experimental results obtainable so far and analyses of large explosions are discussed with a view to their consequences. Special emphasis is placed on the question as to whether extremely unfavourable conditions may lead to a detonation of the cloud instead of a deflagration. Considering the physical laws of cloud formation and the special initiation conditions governing free gas-air-mixtures as a result of gas dynamics and reaction kinetics it can be concluded that a detonation seems to be very unlikely. It is examined what kind of studies are still to be canied out in order to clarity the question of a possible detonation. On the other hand, it is not yet possible to give a decisive answer to the question of whether and to what extent nuclear power plants are endangered by gas cloud deflagration. Due to the complex wave field resulting from diffraction and reflexion of the incoming pressure wave by the buildings of the nuclear power station, a variety of stress functions are possible that may, under certain circumstances, lead to a selective excitation of single vibration modes of the structure.

40911 (BNL-NUREG—25421) **Applicability of microwave heating to the simulation of the LMFBR meltdown process.** Makowitz, H.; Ginsberg, T. (Brookhaven National Lab., Upton, NY (USA)). Dec 1978. Contract EY-76-C-02-0016. 7p. (CONF-790602—11). Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; Atlanta, GA, USA (3 Jun 1979).

In the analysis of post accident heat removal (PAHR) following a hypothetical core-disruptive accident (HCDA) in an LMFBR one is faced with the problem of simulating a boiling pool of a fissile fuel, steel mixture. Previous work at Argonne National Laboratory has recommended that a small scale simulation study of melt-through by microwave heating would be useful on the basis of scoping studies which indicate that the internal heating is quite uniform. In the present work, the effects of droplet size, temperature, dielectric properties and wavelength on the absorption efficiency are investigated and the appropriate materials for obtaining near equal volume heating over a range of droplet sizes of 5.0×10^{-4} cm to 10 cm in radius are suggested for a suitable wavelength.

40912 (BNL-NUREG—25575) **Microwave heating simulations of fission energy generation in volume-boiling pool systems.** Makowitz, H.; Ginsberg, T. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 8p. (CONF-790602—4). Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; Atlanta, GA, USA (3 Jun 1979).

The transition phase of the (hypothetical) loss-of-flow accident in LMFBR's may be characterized by the temporary entrapment of boiling pools of molten fuel and steel within the original core boundaries. Experiments to investigate the multiphase flow and heat transfer characteristics of such systems have been performed and are planned in which simulant fluids are volume-heated by microwave electromagnetic radiation. It has been assumed that the microwave radiation provides a spatially uniform energy source per unit volume of liquid in multiphase flow geometries. It is known, however, that energy absorption by dielectrics in a microwave electromagnetic field is a function of geometry, dielectric properties, and wavelength of the radiation. At high power density, volume-heated boiling pools exhibit a complex two-phase, liquid-vapor, geometric structure. Dispersed droplets, with diameters less than 1 mm, in a vapor continuum may coexist with continuous liquid structures of centimeter scale or greater. This study was performed to: (i) investigate the uniformity of microwave heating in boiling pool systems as a function of liquid geometry; and (ii) design an experimental system employing microwave heating in which the heat generation rate per unit volume of liquid is independent of geometric structure. The results of the study are presented.

40913 (BNL-NUREG—25617) **Development of BNL Heat Transfer Facility 1: flashing experiments.** Leonhardt, W.J.; Klein, J.H.; Zimmer, G.A.; Abuaf, N.; Jones, O.C. Jr. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 14p. (CONF-790602—6). Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; Atlanta, GA, USA (3 Jun 1979).

A major area of interest to reactor safety technology is the prediction of actual vapor generation rates under conditions of thermal nonequilibrium as would be encountered during a loss-of-coolant accident (LOCA) in a light water reactor. In support of the development of advanced codes dealing with LOCA induced flashing, analytical models of the nonequilibrium vapor generation processes of interest have been formulated, and an experimental facility has been constructed to provide data to verify these models. This facility is known as BNL Heat Transfer Facility. The experimental facility consists of a flow loop, test section and the data acquisition and analysis system. The main portion of the flow loop is constructed from three inch nominal (7.6 cm) stainless steel pipe. High purity water is circulated through the loop using a centrifugal pump rated 1500 l/min at 600 kPa. Very close and stable control of all loop parameters is required since flashing is sensitive to very small changes in such parameters as flow rate, subcooling, and pressure.

40914 (CAAP-TR—046) **Improved RELAP4 Jet Pump Model.** Ross, E.E. (Idaho National Engineering Lab., Idaho Falls (USA)). Apr 1979. Contract EY-76-C-07-1570. 60p. Dep. NTIS, PC A04/MF A01.

An improved RELAP4 Jet Pump Model was developed based on subscale jet pump tests. This work was part of the INEL technical support to the NRC for Industry Cooperative Programs. Model evaluation results show the model to be an improvement of the previous model.

40915 (CDAP-TR—053) **Fuel vapor pressure (FVAPRS).** Mason, R.E. (Idaho National Engineering Lab., Idaho Falls (USA)). Apr 1979. Contract EY-76-C-07-1570. 50p. Dep. NTIS, PC A03/MF A01.

A subcode (FVAPRS) is described which calculates fuel vapor pressure. This subcode was developed as part of the fuel rod behavior modeling task performed at EG & G Idaho, Inc. The fuel vapor pressure subcode (FVAPRS), is presented and a discussion of literature data, steady state and transient fuel vapor pressure equations and estimates of the standard error of estimate to be expected with the FVAPRS subcode are included.

40916 (CONF-770807—Pt.F, pp vp) **Dynamic analysis of reactor coolant systems under LOCA condition** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The procedures described include structural modeling and analytical techniques for a non-linear time history dynamic analysis of a three dimensional coupled model of the reactor coolant system including details of the reactor internals, pressure vessel, supports

and piping. The dynamic analysis is performed to determine the response of the reactor coolant system supports to the simultaneous effects of pipe break thrust and external and internal horizontal and vertical asymmetric pressure loads applied to the reactor vessel and internals as a consequence of the postulated pipe rupture. Condensed structural models are created from highly detailed representations of each component by maintaining response frequency characteristics and interface response compatibility. The location, type and size of the pipe breaks have been determined by stress survey and mechanistic break area criteria. Examples of internal and external forcing functions on the vessel and internals, as well as their separate and combined effects on the reactor vessel supports are illustrated. The pressurized water reactor internals, including the fuel and supporting structures, are suspended from the closure flange region of the reactor vessel and surrounded by a cylindrical 'core support barrel' (CSB). The vessel in turn is surrounded by the biological shield wall. The CSB and reactor vessel are essentially concentric cylinders throughout the length of the CSB. The hydraulic loads applied internal to the vessel are determined by use of qualified thermo hydraulic analysis codes such as those of WHAM, FLASH or RELAP series. The dynamic analysis of the mathematical models subjected to these loads is performed using the STRUDL code to define the characteristics of the structure and the CE program DAGS to calculate the non-linear time history response.

40917 (CONF-770807—Pt.F, pp vp) **Influence of multiple loadings to plastic pipe elements. Applications to the pipe whip problem.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper is a contribution to the study of the pipe whip accident considering various effects (pressurization, presence of bending in two normal planes, shears, torque, normal force) which have been previously neglected by the author in precedent works on the same subject for simplicity reasons. A model for a strain hardening plastic pipe element has been proposed; the main hypotheses are briefly reviewed: plastic flow rule; a strain hardening rule; two models have been proposed in the so-called strain model, the section is supposed to remain plane and not to warp even under the influence of shear loads, in the so-called mixed model while the same hypothesis is made for axial strains a truncated Fourier expansion is assumed for the shear stress distribution; in this way a complete stiffness and the influence of section deformation (ovalization due to radius changes in the plastic range (possibly loading to Brazier type instability) can be taken into consideration. The two models (strain model and mixed model) are compared in terms of the results which may be obtained by the use of each of them: it results that in the cases investigated the differences are not large in terms of curvature changes (while it may be somewhat more important in terms of the shear strains). Tentative conclusions are drawn, in the form of graphs taking the differences with the basic simplified model as a main point. Finally, typical real load time histories for one pipe element are considered and the differences with simplified models in the displacements and stress-strain distribution are shown and discussed.

40918 (CONF-770807—Pt.F, pp vp) **Gapped restraints and pipe whipping.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Computer programs to analyze the elastic piping systems have been well developed in the industry. The addition of a routine simulating the linear and nonlinear gapped restraints results in an updated computer program which can be used to analyze the interaction of elastic piping systems with gapped pipe whip restraints. The characteristics of these restraints are generally derived from the corresponding load deflection curves. The equilibrium path of the restraint is dominated by the following types of loading modes; monotonic loading, unloading and reloading. Note that the augmented gap caused by the permanent deformation of the restraint typifies the pattern of its equilibrium path. To account for the inelastic behavior of pipe cross sections, however, it is necessary to take on the yield criterion as well as the normality principle in the force space of each pipe cross section. For two dimensional piping systems, the only dominant parameter in the force space is the bending moment; hence, an analysis based upon the plastic hinge concept may give accurate solutions. However, for general three dimensional piping systems, the interaction of all six resultant forces in each yielded pipe cross section dominates the inelastic responses of piping systems. In this presentation, a quadratic yield surface has been used to cope with the resultant forces. A numerical step-by-step integration, together with the initial force iterative scheme has been accordingly incorporated to conduct nonlinear dynamic plastic analysis of piping systems with initially gapped restraints. In this manner, a computer program, DYNPLA, has been developed and is capable of conducting all the four possible responses in the interaction of pipe whipping and gapped restraints. The effectiveness and comprehensiveness of the DYNPLA program is demonstrated by the results of various sample problems presented in this paper.

40919 (CONF-770807—Pt.F, pp vp) **Experimental model parameters for pipe whip.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

40920 (CONF-770807—Pt.F, pp vp) **Large deflection, elastic-plastic response of piping: experiment, analysis and application.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The effects of postulated high-energy pipe rupture must be evaluated in the design of nuclear power plants. Methods for evaluating one aspect of this accident, pipe whip and restraint impact, require solutions based on non-linear inelastic dynamics. One of the programs developed is a significant extension of the JET series of computer codes developed at the Massachusetts Institute of Technology, Aeroelastic and Structures Research Laboratory. A primary modification was the extension of the inelastic model to enable the code to handle tubular pipe cross-sections. This not only included the inelastic properties of the tubular cross section, but also the effects of local buckling. Improved impact logic was also provided. A description of the theoretical basis of this code, called DINASAW (Dynamic Inelastic Nonlinear Analysis by Stone and Webster), is provided. To verify the accuracy of the computer code, a series of tests were performed. Sections of 1 1/2 in diameter A-106, Grade B, pipe were supported in a cantilever configuration and impulsively loaded in the transverse direction at the free end. The time response of the piping was determined using high extension strain gages connected to oscillographic displays. These were located both on the tensile and compressive sides of the pipe at two stations along the length. In addition, a high speed movie camera was used to record the dynamic deflection. The final set of the pipe, including the degree of plastic bending along the length and local buckling near the built-in end, was measured and compared to the computer solutions. Back-up tests consisted of tensile coupons of the piping material and explosive calibration tests used to evaluate the amplitude of the impulsive load. Tests results are provided and compared to the analytical predictions from DINASAW code.

40921 (CONF-780819—P1, pp 8-30) **Risk-assessment techniques and the reactor licensing process.** Levine, S. (Nuclear Regulatory Commission, Washington, DC). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

A brief description of the Reactor Safety Study (WASH-1400), concentrating on the engineering aspects of the contribution to reactor accident risks is followed by some comments on how we have applied the insights and techniques developed in this study to prepare a program to improve the safety of nuclear power plants. Some new work we are just beginning on the application of risk-assessment techniques to stablize the reactor licensing process is also discussed.

40922 (CONF-780819—P1, pp 32-50) **Review of failures in nuclear air cleaning systems (1975—1978).** Moeller, D.W. (Harvard School of Public Health, Boston, MA). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

During the period from January 1, 1975 through June 30, 1978, over 9,000 Licensee Event Reports (LERs) pertaining to the operation of commercial light water nuclear power plants in the US were reported to the Nuclear Regulatory Commission. Of these reports, over 1,200 (approximately 13%) pertained to failures in air monitoring, ventilating and cleaning systems. For BWR installations, over half of the reported events related to failures in equipment for monitoring the performance of air cleaning systems as contrasted to failures in the systems themselves. In PWR installations, failures in monitoring equipment amounted to about 32% of the total. Reported problem areas in BWR installations included the primary containment and standby gas treatment and off-gas systems, as well as the High Pressure Coolant Injection and Reactor Core Isolation Systems. For PWR installations, reported problem areas included primary containment and associated spray systems and waste processing equipment. Although data on reported failures in power reactor installations can be interpreted in a variety of ways, one message is clear. There is a need for research on the development of more reliable equipment for sampling and monitoring air systems. Equipment that provides inaccurate data on the performance of such

systems can lead to as many problems as inadequacies in the systems themselves.

40923 (CONF-780819—P1, pp 61-67) **Report on ANSI/ASME nuclear air and gas treatment standards for nuclear power plants.** Fish, J.F. (American Air Filter Co., Inc., Lousiville, KY). Feb 1979.
From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Original N Committee, N45-8, has completed and published through the approved American National Standards Institute process two Standards, N-509 and N-510. This committee has been dissolved and replaced by ASME Committee on Nuclear Air and Gas Treatment with expanded scope to cover not only air cleaning, but thermal treatment equipment. Current efforts are directed to produce Code documents rather than Standards type publications. This report summarizes changed scope, current organization and sub-committee coverage areas.

40924 (CONF-780819—P1, pp 257-265) **Study of the containment system of the planned SNR-2 Fast Breeder Reactor.** Bunz, H. (Kernforschungszentrum Karlsruhe GmbH, Germany); Scholle, U. Feb 1979.
From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Research is presented concerning the behaviour of four possible containment concepts for the planned Fast Breeder Reactor SNR-2 under the conditions of a HCDA. Detailed descriptions and calculations are given dealing with the acceptable leakages and the filter loads reached. The transport of the aerosol-type as well as the gaseous activity through the different compartments into the environment is calculated and from this the resulting accident doses. To cover the uncertainties of the accident course a wide range of accident parameters is examined.

40925 (CONF-780819—P1, pp 266-278) **FISSION 2120: a program for assessing the need for engineered safety feature grade air cleaning systems in post accident environments.** Martin, G. Jr.; Michlewicz, D.; Thomas, J. (Ebasco Services Inc., New York, NY). Feb 1979.
From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

A computer program FISSION 2120, has been developed to evaluate the need for various engineered Safety Feature grade air cleaning systems to mitigate radiation exposures resulting from accidential releases of radioactivity. Those systems which are generally investigated include containment sprays with chemical additives, containment fan coolers with charcoal filters, and negative pressure maintenance systems for double barrier containments with either one-pass filtration or recirculation with filtration. The program can also be used to calculate the radiation doses to control room personnel. This type of analysis is directed towards the various protection aspects of the emergency ventilation system and involves the modeling of the radiological source terms and the atmospheric transport of the radioactive releases. The modeling is enhanced by the inherent capability of the program to accommodate simultaneous release of activity from several sources and to perform a dose evaluation for a wide range of the design characteristics of control room emergency air filtration systems. Use of the program has resulted in considerable savings in the time required to perform such analyses and in the selection of the most cost-effective Engineered Safety Features.

40926 (CONF-780819—P1, pp 299-312) **Confirmatory research program: effects of atmospheric contaminants on commercial charcoals.** Bellamy, R.R. (Nuclear Regulatory Commission, Washington, DC); Dietz, V.R. Feb 1979.
From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

The increased use of activated charcoals in engineered-safety-feature and normal ventilation systems of nuclear power stations to continually remove radioiodine from flowing air prior to release to the environment has added importance to the question of the effect of atmospheric contaminants on the useful life of the charcoal. In January of 1977 the Naval Research Laboratory (NRL) began an investigation to determine the extent to which atmospheric contaminants in ambient concentrations degrade the efficiency of various commercially-available charcoals for removing methyl iodide. The approach employed by NRL is two-fold. First, charcoal samples are exposed to unmodified outdoor air for periods of one to nine months, then examined for methyl iodide retention, increase in weight, and the pH of water extract. The atmospheric contaminants are identified by the NRL Air Quality Monitoring Station, and concentrations of the various contaminants (ozone, SO_2, NO_2, CO_2, methane and total hydrocarbons) are also available. Second, additional charcoal samples are exposed to the same pollutants under controlled laboratory conditions in various pollutant combinations. Results indicate that the water vapor-charcoal interaction is an important factor in the degradation of the commercial charcoals. Laboratory results indicate the pollutant sulfur dioxide plus water vapor can result in significant charcoal deterioration, as did ozone plus water vapor. Conversely, carbon monoxide did not appear to affect the charcoal. Also, differences were observed for various charcoals.

40927 (CONF-780819—P2, pp 666-687) **Air cleaning system isolation during tornado conditions.** Pysh, W.A.; Clements, T.A. (Techno Corp., Erie, PA). Feb 1979.
From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

The occurrence of a tornado at the site of an operating nuclear power generating station creates unstable atmospheric conditions which can be detrimental to the proper operation of the plant air cleaning system. One means of mitigating or preventing this hazard is isolation of the system from the unstable environment by closure of the system openings during the unstable conditions. For maximum system protection the closure should be an automatic response to the adverse conditions themselves, without reliance on manual or remote sensing or signals. The interaction of tornado characteristics with velocity/pressure sensitive isolation devices is modeled. Force and time relationships are investigated to evaluate and predict the interaction. Laboratory test apparatus is developed for simulating the flows and pressures induced by the tornado at system openings. Several isolation devices of various sizes are subjected to a range of simulated tornado conditions for observation and evaluation of response time, sensitivity, and dyamic closing forces. The model, apparatus, experimentation, and results are presented.

40928 (CONF-780819—P2, pp 688-693) **Evaluating nuclear power plant ventilation system adequacy in reducing airborne radioactivity exposure.** Jouris, W.E. (King Faisal Specialist Hospital and Research Centre, Riyakh, Saudi Arabia). Feb 1979.
From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

The problem of analyzing the effectiveness of the ventilation system for reducing airborne radioactivity exposure of personnel in a nuclear power plant is one faced by many nuclear analysis groups in power plant design organizations. This paper presents a rational way of approaching the problems and some simple methods of solving them. In so doing reasonable component leakage values are developed which can be used in solving this and other problems. For chronic leakage the values of 0.11b/h for valves, strainers and flanges are derived and 0.5lb/h for pumps on other active components.

40929 (CONF-780819—P2, pp 764-791) **Sodium oxide/hydroxide aerosol properties and behavior in a large vessel.** Hilliard, R.K.; McCormack, J.D.; Hassberger, J.A.; Postma, K.A. (Westinghouse Hanford Co., Richland, WA). Feb 1979.
From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Two large-scale aerosol behavior tests were performed in the Containment Systems Test Facility (CSTF) using sodium pool fires as the aerosol source. The purpose was to characterize the properties and behavior of sodium aerosol particles formed and aged in a large containment vessel. The results will be used as baseline data for comparison with follow-on air cleaning tests. The 20-m high, 850-m^3 CSTF containment vessel is approximately half scale of a commercial reactor containment building for parameters which affect agglomeration and gravitational settling. Thus, the test air cleaning systems will be challenged with an aerosol closely representative of that postulated for LMFBR accidents. The results of these tests also offer an excellent opportunity to evaluate computer models which have been developed for the purpose of predicting aerosol behavior during hypothetical accidents in sodium cooled reactor containment spaces. The two tests differed only in that steam was injected in the second test to simulate the release of water vapor from heated concrete. The aerosol in the first test was a dry mixture of sodium peroxide, sodium hydroxide and sodium carbonate. In the second test it was predominantly wet sodium hydroxide. The addition of water vapor caused more rapid fallout during the aerosol release period, but lower settling rates afterward. The net results was a 25% lower potential for aerosol leakage in the wet test. Detailed analyses of computer model comparisons have not yet been performed, but preliminary HAA-3B code predictions were in good agreement with suspended mass concentration and the ratio of mass settled to plated on walls.

40930 (CONF-780819—P2, pp 792-804) **Attenuation of particles through leak paths.** Nelson, C.; Johnson, R. (Atomics International Div., Canoga Park, CA). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Particulates of sodium oxide were passed through narrow leak passages. The particulates impacted on the walls and built up plugs which eventually stopped the flow. Conditions under which plugging occurs were determined. Material which did pass through the leaks was increased in size because of agglomeration on the wall followed by detachment. The data shows that radioactive particulates escaping through leaks following a hypothetical FBR accident will tend to plug the leaks in both the reactor vessel and the containment building. Also, the particulates will generally increase in size so as to be nonrespirable.

40931 (CONF-780819—P2, pp 916-934) **Inorganic radioiodine adsorber with low noble gas retention.** Distenfeld, C.; Klemish, J. (Brookhaven National Lab., Upton, NY). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

A silver loaded silica gel was developed as an adsorber for air monitoring subsequent to a release from containment power reactor accident. Requirements of high efficiency for known radioiodine species under wide ambient conditions of humidity and temperature and low noble gas adsorption efficiency are satisfied by the material. Silver loadings from 2 to 24% by adsorber weight have been tested against organic radioiodine, hypoiodous acid, elemental radioiodine, and noble fission gases. Relative humidity was varied between 5 and 99%, and stay times of .11, .073, and .55 seconds were used. Silver loading requirements depend on sampling duration and relative humidity. Environmental monitoring, to define safe living areas, requires about 25 ft^3 of air be sampled and analyzed by the proposed system of an air mover, an adsorber, and a civil defense readout instrument. A silica gel adsorber can be used with a 4% silver loading for an efficiency of better than 93% with a .11 second stay time, and for all ambient conditions tested. Similar tests using 4% silver loaded 13X molecular sieve or about 60% silver zeolite yield lower efficiencies. Xenon adsorption was $< 5 \times 10^{-3}$% at 55°C with no post-release flushing. This value was about 1/20 of the value for charcoal under the same conditions. A silver loading apparatus was developed to easily process ~ 5 Kg of silica gel per day. The method involves prehumidification, boiling under high vacuum, oven drying, sieving, and finally packaging.

40932 (CONF-780819—P2, pp 984-986) **Use of installed test cannisters for representative sampling of ventilation systems charcoal absorbers.** Moore, C.A. (Florida Power and Light, Ft. Pierce). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

In Nuclear Power Plants, activated charcoal is routinely installed in Energency Safeguards Ventilation Systems for reduction of iodine releases under postulated post-acident clean-up conditions. Since charcoal is subject to several types of degradation; representative sampling methods must be utilized in order to perform analyses to ensure these systems are maintained at a proper level of iodine removal efficiency. A common method of sampling currently in use is to install small test cannisters containing charcoal from batches used to fill the main absorber beds. These are usually placed so that the samples are exposed to the same general environmental conditions as the absorbers, i.e., temperature, humidity, etc. A test program at the St. Lucie plant to confirm that the flow conditions of the test cannisters is the same as the main absorbers is described.

40933 (CONF-780819—P2, pp 1044-1057) **Performance of a wet cell washer for sodium fire aerosols.** Hinds, W.; Price, J.; First, M.W. (Harvard Air Cleaning Lab., Boston, MA). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

The sutiability of 6 packing materials for removal of sodium fire aerosols in a wet cell scrubber was evaluated experimentally by measuring the efficiency and flow resistance of two 10.2 cm deep cells in series at air face velocities of 185 and 289 cm/sec, water flow rates of 0.210 and 0.387 $cm^3/sec/cm^2$, with and without aerosol prehumidification. The most satisfactory material was found to be 50 μm diameter stainless steel fibers at a packing density of 30 kg/m^3 (porosity = 0.99). Two 10.2 cm deep cells in series gave a removal efficiency of 85% for typical sodium fire aerosols at a face velocity of 289 cm/sec. Measurement of efficiency as a function of particle size indicated a reduction in efficiency in the 0.4 to 1.1 μm size range for all packing materials.

40934 (CONF-780819—P2, pp 1159-1175) **Evaluation of data from HEPA filter quality assurance testing stations.** Collins, J.T.; Bellamy, R.R.; Allen, J.R. (Neuclear Regulatory Commission, Washington, DC). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

In Revision 1 to Regulatory Guide 1.52, issued in July 1976, the NRC recommended that high efficiency particulate air (HEPA) filters for use in engineered safety features (ESF) atmosphere cleanup systems be visually inspected and dioctylphtalate (DOP) tested at either of two Department of Energy (DOE) operated QA Filter Testing Stations prior to their installation and use in commercial nuclear power plants. This practice was initiated because filter vendors were unable to consistently provide a HEPA filter that would meet the stringent requirements established by DOE and NRC and its predecessor the AEC. In 1977, the NRC staff undertook a program to revise Regulatory Guide 1.52 to reflect recently issued industry standards (e.g., ANSI N509 and N510) and current industry practices. Revision 2 to Regulatory Guide 1.52 was formally issued in March 1978. In conducting this review, the recommendation that HEPA filters, intended for use in ESF systems in commercial nuclear power plants, be routinely tested at the DOE-QA Filter Testing Stations was revaluated. As part of this evluation a detailed analysis of the filter test results recorded by the two QA Testing Stations during the period 1971 to 1977 was conducted. This paper summarizes the results of the analysis and explains the rationale for deleting the requirement that all HEPA filters intended for use in ESF systems be tested at the AQ Testing Station.

40935 (CONF-790361—1) **Fuel and coolant motions following pin failure: EPIC models and the PBE-5S experiment.** Garner, P.L.; Abramson, P.B. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 14p. Dep. NTIS, PC A02/MF A01.

From LMFBR workshop; Albuquerque, NM, USA (12 Mar 1979).

The EPIC computer code has been used to analyze the post-fuel-pin-failure behavior in the PBE-5S experiment performed at Sandia Laboratories. The effects of modeling uncertainties on the calculation are examined. The calculations indicate that the majority of the piston motion observed in the test is due to the initial pressurization of the coolant channel by fuel vapor at cladding failure. A more definitive analysis requires improvements in calculational capabilities and experiment diagnostics.

40936 (CONF-790423—10) **Evaluation of the effect of break nozzle configuration in loss-of-coolant accident analysis.** Hanson, R.G. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 12p. Dep. NTIS, PC A02/MF A01.

From 2. multiphase flow and heat transfer symposium workshop; Miami Beach, FL, USA (16 Apr 1979).

The Semiscale Mod-1 test program has utilized two different break nozzle configurations in a test facility with identical initial and boundary conditions. An evaluation has been made to determine the effect these break nozzle configurations have on system thermal-hydraulic response during a 200% double-ended cold leg break loss-of-coolant accident simulation. The first nozzle had a convergent-divergent design; the second nozzle had a convergent design with an elongated constant area throat followed by a rapid expansion. Analysis of data from tests conducted with the two nozzles shows that the critical flow characteristics at the break plane were affected by the break nozzle geometry. Differences in break flow caused differences in the core inlet flow which in turn affected core heater rod thermal response. The results of this investigation show that the break flow behavior and the resulting core thermal response in the Semiscale experimental facility can be directly correlated.

40937 (CONF-790441—3) **Light water reactor fuel response during reactivity initiated accident experiments.** MacDonald, P.E.; McCardell, R.K.; Martinson, Z.R.; Hobbins, R.R.; Seiffert, S.L.; Cook, B.A. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 9p. Dep. NTIS, PC A02/MF A01.

From ANS topical meeting on light water reactor fuel performance; Portland, OR, USA (29 Apr 1979).

Experimental results from six recent Power Burst Facility (PBF) reactivity initiated accident (RIA) tests are compared with data from previous SPERT, TREAT and NSRR programs. The RIA fuel behavior experimental program recently started in the PBF is being conducted with coolant conditions typical of hot-startup conditions in a commercial boiling water reactor. The SPERT, TREAT and NSRR test programs investigated the behavior of single or small clusters of light water reactor (LWR) type fuel rods under approximate room temperature and atmospheric pressure conditions in capsules containing stagnant water. As observed in the previous tests, energy depositions, and consequent enthalpy increase, in the PBF test fuel appears to be the single most important variable. However, the consequences of failure at boiling water hot-startup system conditions appear to be more severe than previously observed in either the stagnant SPERT or NSRR tests. Metallographic examination of both previously unirradiated and irradiated PBF fuel rod cross sections revealed extensive variation in cladding wall thickness involving considerable plastic flow and fuel shattering

along grain boundaries in both restructured and unrestructured fuel regions. In addition, swelling of the gaseous and potentially volatile fission products in previously irradiated fuel resulted in volume increases of up to 180% and blockage of the flow shrouds surrounding the fuel rods.

40938 (CONF-790505—8) **LOFT two-phase flow data integrity analysis.** Goodrich, L.D.; Leach, L.P. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 3p. Dep. NTIS, PC A02/MF A01.

From 25. ISA international instrumentation symposium; Anaheim, CA, USA (7 May 1979).

Data integrity methods have been developed and applied to Loss-Of-Fluid Test (LOFT) nuclear reactor safety experiments at the Idaho National Engineering Laboratory. The methods for improving and qualifying the accuracy of transient measurements on complex thermal-hydraulic experiments are described. These methods involve use of all the information available on the transducers, including data taken during the LOFT experiment itself. Optimum use of these methods determine, in part, the instrumentation package provided on the experiment.

40939 (CONF-790602—16) **Steam generator tube rupture effects on a LOCA.** LaChance, J.L. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 4p. Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; Atlanta, GA, USA (3 Jun 1979).

A problem currently experienced in commercial operating pressurized water reactors (PWR) in the United States is the degradation of steam generator tubes. Safety questions have arisen concerning the effect of these degraded tubes rupturing during a postulated loss-of-coolant accident (LOCA). To determine the effect of a small number of tube ruptures on the behavior of a large PWR during a postulated LOCA, a series of computer simulations was performed. The primary concern of the study was to determine whether a small number (10 or less of steam generator tubes rupturing at the beginning surface temperatures. Additional reflood analyses were performed to determine the system behavior when from 10 to 60 tubes rupture at the beginning of core reflood. The FLOOD4 code was selected as being the most applicable code for use in this study after an extensive analysis of the capabilities of existing codes to perform simulations of a LOCA with concurrent steam generator tube ruptures. The results of the study indicate that the rupturing of 10 or less steam generator tubes in any of the steam generators during a 200% cold leg break will not result in a significant increase in the peak cladding temperature. However, because of the vaporization of the steam generator secondary water in the primary side of the steam generator, a significant increase in the core pressure occurs which retards the reflooding process.

40940 (CONF-790602—19) **LOFT blowdown experiment safety analysis methodology.** Perryman, J.L.; Cooper, C.H.; Samuels, T.K. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 6p. Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; Atlanta, GA, USA (3 Jun 1979).

An unprecedented blowdown experiment safety analysis (ESA) has been performed for the first two scheduled nuclear experiments in the Loss-of-Fluid Test (LOFT) facility. The ESA methodology is a unique approach needed to estimate conservatively the maximum consequences that will occur during an experiment. Through use of this information an acceptable risk in terms of adequate protection of the facility, personnel, and general public can be balanced with the requirements of the experiment program objectives. As an example, one of the LOFT program objectives is to evaluate the performance and effectiveness of emergency core cooling systems (ECCS) while relying on the same ECCSs (and backup ECCSs) to effectively perform as plant protection systems (PPS). The purpose of this paper is to present the LOFT blowdown ESA methodology.

40941 (CONF-790602—20) **Improved RELAP4 BWR jet pump model.** Ross, E.E.; Charlton, T.R. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-04-1570. 5p. Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; Atlanta, GA, USA (3 Jun 1979).

A RELAP4 Boiling Water Reactor (BWR) jet pump model development effort is being conducted to develop a new RELAP4 BWR jet pump model from test data. Results from the Jet Pump Test and Model Development Program conducted at the Idaho National Engineering Laboratory (INEL) are being used. The overall program consisted of three phases, subscale testing, model development, and model evaluation. This paper includes a program description, a model description, and a model evaluation.

40942 (CONF-790602—28) **Pre-LOCE thermal safety analysis of the LOFT reactor L2-2 experiment.** Atkinson, S.A.; Elger, D.F.; Fisher, J.E. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 6p. Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; Atlanta, GA, USA (3 Jun 1979).

This study discusses the method of assuring adequate thermal safety margins for LOFT reactor operating conditions prior to a Loss of Coolant Experiment (LOCE). The L2-2 experiment, completed in December 1977, was the first large scale simulation of a LPWR double-ended pipe break. Test predictions and data analysis are only part of the LOFT effort. Also, adequate safety margins must be demonstrated for low flow conditions prior to a LOCE. This effort presents a unique problem because the initial LOCE test conditions require an operation with significant maximum linear heat generation rate (26.3 Kw/m for L2-2) with only 40% of normal core flow. The analysis logic is to assure adequate safety margin (ability to operate within acceptable consequence levels) by performing bounding calculations. With a few minor exceptions,no statistical combinations of uncertainties were made. Thus there is a high degree of confidence in the analyses conservatism.

40943 (CONF-790602—36) **Whole-core thermal-hydraulic transient code development and verification for LMFBR analysis.** Spencer, D.R. (Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.). Apr 1979. Contract EW-76-C-15-2395. 5p. Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; Atlanta, GA, USA (3 Jun 1979).

Predicted performance during both steady state and transient reactor operation determines the steady state operating limits on LMFBRs. Unnecessary conservatism in performance predictions will not contribute to safety, but will restrict the reactor to more conservative, less economical steady state operation. The most general method for reducing analytical conservatism in LMFBR's without compromising safety is to develop, validate and apply more sophisticated computer models to the limiting performance analyses. The purpose of the on-going Natural Circulation Verification Program (NCVP) is to develop and validate computer codes to analyze natural circulation transients in LMFBRs, and thus, replace unnecessary analytical conservatism with demonstrated calculational capability.

40944 (CONF-790615—2) **Considerations of scaling effects in the LOFT reactor system during a large break LOCA simulation.** Langerman, M.A.; Harvego, E.A. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 4p. Dep. NTIS, PC A02/MF A01.

From 3. US national congress on pressure vessels and piping; San Francisco, CA, USA (25 Jun 1979).

An investigation was performed to assess the effects of scale in a reduced-scale integral test facility designed to simulate the response of a commercial four-loop pressurized water reactor (PWR) during a hypothesized loss-of-coolant accident (LOCA). The facility considered in the investigation was the Loss-of-Fluid Test (LOFT) system, which simulates the principal physical features of a PWR, but has only one-fiftieth of the fluid volume. LOFT experimental data and data from comparable Semiscale Mod-1 and Mod-3 tests were used to assess the influences of component scaling characteristics on LOFT performance during a 200% cold leg break LOCA simulation.

40945 (COO—2571-14) **Improvement and verification of fast reactor safety analysis techniques. Progress report, July 1, 1978—September 30, 1978.** Barker, D.H.; Wheeler, P.; Bybee, D.J. (Brigham Young Univ., Provo, UT (USA). Dept. of Chemical Engineering). 1978. Contract EY-76-S-02-2571. 169p. Dep. NTIS, PC A08/MF A01.

This report deals with the simulation of a HCDA in a LMFBR using chemical heating. The chemicals used were acetyl chloride and dimethyl sulfoxide in a benzene base. In our last report, it was shown that for high concentrations of the two chemicals, vapor velocities above 8 cm/sec and void fractions above 50% were obtained in a closed system. However, at lower concentrations, such as 4 M, no void fraction was obtained. During this period of work, a closed system with a cooling coil was used to provide a larger heat sink. It was shown that for the 4 M concentration void fractions above 50% was obtained and for the 9 M concentration the void fraction was higher and stayed dispersed much longer than without the cooling coil.

40946 (COO—2571-15) **Improvement and verification of fast reactor safety analysis techniques. Progress report, October 1, 1978—December 31, 1978.** Barker, D.H.; Wiberg, D.V. (Brigham Young Univ., Provo, UT (USA). Dept. of Chemical Engineering). 1978. Contract EY-76-S-02-2571. 11p. Dep. NTIS, PC A02/MF A01.

The effect of using Acetone, Benzene, or Toluene as a solvent material in a 4M, Acetyl Chloride-Dimethyl Sulfoxide reaction system was investigated. Maximum void fraction and length of time with void greater than 50% were compared. The Acetone system produced the largest maximum void and longest time above 50% void followed by Benzene and Toluene in descending order. Seventeen waxes were tested and compared to determine a material suitable to simulate reactor containment materials (e.g., steel, con-

crete). Waxes were compared on the basis of solubility in the reaction materials, melting point and structural integrity.

40947 (COO—2826-11) **Fast Breeder Blanket Facility. Quarterly progress report, October 31, Dec 1978—December 31, 1978.** Clikeman, F.M. (ed.). (Purdue Univ., Lafayette, IN (USA). School of Nuclear Engineering). Dec 1978. Contract EY-76-S-02-2826. 131p. Dep. NTIS, PC A07/MF A01.

This quarterly progress report summarizes the work performed using Purdue University's Fast Breeder Blanket Facility for the Department of Energy during the months October—December 1978. The summary includes a final report on the safety evaluation of the hypothetical flooding accident which has had a major influence on the design of the facility. Progress on the development and testing of the experimental technique is also summarized. Preliminary results of the ^{115}In(n,γ)/sup 116m/In and ^{115}In(n,n')/sup 115m/In reactions are presented.

40948 (DOE/TIC—10102) **Analysis of TREAT Tests L7 and L8 with SAS3D, LEVITATE and PLUTO2.** Bowers, C.H.; Tentner, A.M.; Wider, H.U. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 17p. Dep. NTIS, PC A02/MF A01.

Fuel motion in TREAT Tests L7 and L8 is analyzed with the SAS3D, LEVITATE, and PLUTO2 computer codes. These results are compared with fuel motion data obtained from the fast neutron hodoscope. It is concluded that fission gas acts to disperse fuel during the early stages of fuel motion.

40949 (GEFR—14023-8) **Risk analysis methods development. Eighth quarterly report, October—December 1978.** (General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.). Jan 1979. Contract EY-76-C-03-0893-032. 28p. AT.

The objectives of the program are: (1) to develop and apply methods for R and D planning in support of the Lines-of-Assurance (LOA) strategy and (2) to establish a credible Breeder Reactor (BR) risk assessment basis for evaluating R and D overall risk goal accomplishments. The report describes work on the Procedural Manual for Breeder Reactor Risk Assessment and development of a consistent probability model for single plant risk assessment.

40950 (HEDL-SA—1526-FP) **Early-in-life thermal performance of UO_2—PuO_2 fast reactor fuel.** Baker, R.B.; Leggett, R.D. (Hanford Engineering Development Lab., Richland, WA (USA)). 1979. Contract EY-76-C-14-2170. 11p. (CONF-790306—7). Dep. NTIS, PC A02/MF A01.

From International conference on fast breeder reactor performance; Monterey, CA, USA (5 Mar 1979).

Results from the combined analyses of two thermal performance tests, HEDL P-19 and HEDL P-20 are described. The tests were designed to provide data on the power required to cause incipient fuel melting early in life under conditions prototypic of FFTF driver fuel pins and similar FBR fuel systems.

40951 (HEDL-TI—75002-31) **FSAR Amendment 31: changes to section 3.10.** Schade, A.R. (Hanford Engineering Development Lab., Richland, WA (USA)). Mar 1979. Contract EY-76-C-14-2170. 75p. AT.

Revisions to Section 3.10 (Environmental Design of Mechanical and Electrical Equipment) of the FFTF Final Safety Analysis Report are presented.

40952 (HEDL-TME—78-108) **MELT-IIIB: an updated version of the melt code.** Tabb, K.K.; Lewis, C.H.; O'Dell, L.D.; Padilla, A. Jr.; Smith, D.E.; Wilburn, N.P. (Hanford Engineering Development Lab., Richland, WA (USA)). Apr 1979. Contract EY-76-C-14-2170. 104p. Dep. NTIS, PC A06/MF A01.

The MELT series is a reactor modeling code designed to investigate a wide variety of hypothetical accident conditions, particularly the transient overpower sequence. MELT-IIIB is the latest in the series.

40953 (INIS-mf—4541, pp vp) **Measurements of the initial rate of depressurisation following pneumatic rupture of pipes containing defects.** 1977.

In Structural mechanics in reactor technology.

40954 (LA—7557-MS) **Simplified multicomponent phase transition model.** Suo-Anttila, A.J. (Los Alamos Scientific Lab., NM (USA)). Jan 1979. Contract W-7405-ENG-36. 27p. Dep. NTIS, PC A03/MF A01.

A method is presented that will allow one to generate approximate solutions to N- component phase transition problems. There are N-1 species equations and one energy equation, coupled at the phase transition interface by a thermodynamic relationship. The equivalent Couette flow boundary layer equations are utilized to relate the mass and energy fluxes to the overall driving forces. Various simplifying assumptions are made; however, the method is sufficiently general that no simplifying assumptions need be made. A completely rigorous treatment would only introduce additional nonlinearity into the system, rather than change the method.

40955 (LA—7751-P) **Proposal for the transmittal of data to LASL and the reporting of TRAC analyses for the multinational reflood experimental program.** Bleiweis, P.B.; Kirchner, W.L.; Sicilian, J.M. (Los Alamos Scientific Lab., NM (USA)). Apr 1979. Contract W-7405-ENG-36. 16p. Dep. NTIS, PC A02/MF A01.

The proposed form of the digital tape containing the reduced experimental data from any of the 2D/3D facilities (CCTF, SCTF, UPTF, and possibly PKL Core-II) and the procedures which LASL will use in performing TRAC calculations and reporting results are described in this document.

40956 (NUREG/CR—0446) **Determining effectiveness of ALARA design and operational features.** Hall, T.M.; Dodd, A.M.; Haight, R.F. (United Nuclear Industries, Inc., Richland, WA (USA)). Apr 1979. 530p. (UNI-TR—3). NTIS, PC A23/MF A01.

A method developed by United Nuclear Industries, Inc., for determining whether occupational radiation exposures in nuclear power reactors are as low as is reasonably achievable (ALARA) is described. The method for ALARA assessment consists of the following three components: Apparent Reduction Potential (ARP), a ranking method which can be used to set priorities for exposure reduction projects; Achievability Index (AI), a cost/benefit analysis method which can be used to justify exposure reduction projects; and assessment of ALARA using a data handling computer code which can be used to calculate ARP values and to organize data. The seven-step approach taken in developing the method is discussed and the equations defined. A discussion of how to apply the method at a given plant site is presented, along with an example of such an application.

40957 (NUREG/CR—0547) **Light-water-reactor safety research program. Quarterly progress report, July—September 1978.** Sachs, R.G.; Kyger, J.A. (Argonne National Lab., IL (USA)). Jan 1979. Contract W-31-109-ENG-38. 52p. (ANL—78-107). Dep. NTIS, PC A04/MF A01.

This progress report summarizes the Argonne National Laboratory work performed during July, August, and September 1978 on water-reactor-safety problems. The following research and development areas are covered: (1) loss-of-coolant accident research: heat transfer and fluid dynamics; (2) transient fuel response and fission-product release program; and (3) mechanical properties of zircaloy containing oxygen.

40958 (NUREG/CR—0592) **High-temperature gas-cooled reactor safety studies for the Division of Reactor Safety Research. Quarterly progress report, July 1—September 30, 1978.** Ball, S.J.; Cleveland, J.C.; Conklin, J.C. (Oak Ridge National Lab., TN (USA)). 25 Jan 1979. Contract W-7405-ENG-26. 22p. (ORNL/NUREG/TM—293). Dep. NTIS, PC A02/MF A01.

Further assistance was provided to the Nuclear Regulatory Commission (NRC) in confirming emergency core cooling system (ECCS) analyses of the Fort St. Vrain (FSV) reactor in support of a 100% power license application. Comparisons of FSV data from a scram test at 50% power with ORECA code predictions were also made. Other work included further development of the FSV simulation codes.

40959 (NUREG/CR—0610) **Surface heat flux perturbations in BDHT fuel pin simulators.** Ott, L.J.; Childs, K.W. (Oak Ridge National Lab., TN (USA)). 27 Mar 1979. Contract W-7405-ENG-26. 118p. (ORNL/NUREG—54). Dep. NTIS, PC A06/MF A01.

The perturbation is quantified for the surface heat flux and surface temperature in blowdown heat transfer (BDHT) bundle 1 fuel pin simulators due to the presence of the thermocouple and groove, gaps, heater eccentricity, and power zone breaks. Steady-state and transient-case studies are presented to illustrate the azimuthal and axial variations in the surface conditions. The conceptual designs of BDHT bundle 3 fuel pin simulators are also evaluated. Recommendations are made for improvements in the heater designs and for the development of computer codes to analyze the responses of the heater thermocouples.

40960 (NUREG/CR—0653) **Physics of reactor safety. Quarterly report, July—September 1978.** (Argonne National Lab., IL (USA)). Nov 1978. Contract W-31-109-ENG-38. 78p. (ANL—78-106). Dep. NTIS, PC A05/MF A01.

This report summarizes work done on reactor safety program by members of the Reactor Safety Appraisals Group, Monte Carlo analyis of safety-related critical assembly experiments and Planning of Safety-Related (ZPR) Planning and Experiments Group. Work on reactor core thermal-hydraulic code development performed in the Components Technology Division is also included.

40961 (NUREG/CR—0682) **Quarterly progress report on fission product behavior in LWRs for the period October—December 1978.** Malinauskas, A.P.; Lorenz, R.A.; Collins, J.L.; Osborne, M.F.;

Towns, R.L. (Oak Ridge National Lab., TN (USA)). Feb 1979. Contract W-7405-ENG-26. 21p. (ORNL/NUREG/TM—308). Dep. NTIS, PC A02/MF A01.

Current experimental efforts in this program are concerned with the quantitative characterization of fission product release from highly irradiated LWR fuel under hypothetical accident conditions that might exist if the temperature of the fuel were to exceed the upper limit temperature for a controlled LOCA (~ 1200°C) but not reach meltdown. The temperature range 1445 to 1610°C has been explored in two tests, HT-2 and HT-3. Two additional tests with high-burnup H. B. Robinson Reactor fuel have been completed as part of the High Temperature Tests Series. The releases obtained for ^{85}Kr, ^{134}Cs, and ^{129}I in these tests, which are significantly larger than those obtained in previously conducted tests at temperatures up to 1300°C, suggest that some mechanism other than normal diffusion from either the gap or the UO_2 matrix governs the release behavior.

40962 (NUREG/CR—0712) **BWR steady-state capability of the WRAP-EM system.** Sharp, D.A. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Apr 1979. Contract EY-76-C-09-0001. 80p. (DPST-NUREG—78-1). Dep. NTIS, PC A05/MF A01.

The computational procedure used in the WRAP-EM System to determine steady state operating conditions of a boiling water reactor (BWR) is described. WRAP-EM is a modular computational system developed at the Savannah River Laboratory in support of the Nuclear Regulatory Commission program of light water reactor safety analysis. WRAP-EM is capable of performing, automatically, the full scope of calculations required to audit evaluation model analyses of a loss-of-coolant accident (LOCA). This steady state computational procedure can be used to compute the equilibrium state of a BWR system corresponding to a particular system nodalization. With this procedure, BWR transient calculations can be performed without extensive manual calculations of the initial conditions.

40963 (NUREG/CR—0713) **BWR loss-of-coolant accident analysis capability of the WRAP-EM system.** Buckner, M.R.; Beckmeyer, R.R.; Gregory, M.V.; Reed, R.L.; Winn, W.G. (Savannah River Ecology Lab., Aiken, SC (USA)). Apr 1979. Contract EY-76-C-09-0001. 51p. (DPST-NUREG—78-2). Dep. NTIS, PC A04/MF A01.

The modular computational system known as the Water Reactor Analysis Package (WRAP) has been extended to provide the computational tools required to perform a complete analysis of LOCAs in BWRs. The new system is known as the WRAP-EM (Evaluation Model) system and will be used by NRC in interpreting and evaluating reactor vendor EM methods and computed results. The system for BWR-EM analysis is comprised of several computer codes which have been developed to analyze a particular phase of a LOCA. These codes include GAPCON for calculation of initial fuel conditions, WRAP (the previously developed SRL analog of RELAP4/MOD5) for analysis of the system blowdown, NORCOOL for analysis of the reflood phase, and MOXY for the calculation of the fuel assembly hot plane temperature. In addition, a BWR steady-state initialization procedure has been developed to provide the initial operating state of the reactor system. The BWR-EM system is operational and is currently being evaluated to determine the adequacy and consistency of the physical models employed for EM analysis.

40964 (NUREG/CR—0714) **User's guide for the BWR LOCA analysis capability of the WRAP-EM system.** Beckmeyer, R.R.; Gregory, M.V.; Reed, R.L.; Winn, W.G. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Apr 1979. Contract EY-76-C-09-0001. 213p. (DPST-NUREG—78-3). Dep. NTIS, PC A10/MF A01.

The input specifications for the BWR analysis capability of the WRAP-EM system are presented in this document along with the JOSHUA input templates. This document along with the WRAP user's guide provides a step-by-step procedure for setting up a BWR data base for the WRAP-EM system.

40965 (NUREG/CR—0736) **LMFBR fuel analysis. Task C: reliability.** Cave, L.; Kastenberg, W.E. (California Univ., Los Angeles (USA). School of Engineering and Applied Science). Nov 1978. 28p. NTIS, PC A03/MF A01.

The work done by UCLA in the form of consultative support on a variety of topics is summarized briefly. In the case of one particular topic, the problem of establishing an adequate verification program for natural circulation in FFTF, a probabilistic approach was developed which may be of more general interest in relation to other fast reactors. The UCLA paper on this topic is reproduced as an Appendix to this report.

40966 (PB—287079) **Dynamic interaction between adjacent structures. Research report, 1976—1977.** Gonzalez, J.J.; Roesset, J.M. (Massachusetts Inst. of Tech., Cambridge (USA). Constructed Facilities Div.). Sep 1977. 45p. NTIS PC A03/MF A01.

A finite element formulation for the solution of a three-dimensional soil-structure interaction problem is developed, based upon the use of the consistent lateral boundary. The method is applied to the determination of the dynamic stiffness of a square foundation and the results are compared to an equivalent circular footing to check the validity. The underlying soil interaction between two rigid masses is then investigated for the case of a harmonic force applied at the base of one mass, and for the case of a base motion representing seismic excitation, the values of the masses, natural frequencies, and distance between foundations are varied in the investigation.

40967 (SAND—78-1910C) **Comparison of FISGAS swelling and gas release predictions with experiment.** Ostensen, R.W. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 12p. (CONF-790310—4). Dep. NTIS, PC A02/MF A01.

From Specialists workshop on predictive analysis of material dynamics in LMFBR safety expts; Los Alamos, NM, USA (13 Mar 1979).

FISGAS calculations were compared to fuel swelling data from the FD1 tests and to gas release data from the FGR39 test. Late swelling and gas release predictions are satisfactory if vacancy depletion effects are added to the code. However, early swelling predictions are not satisfactory, and early gas release predictions are very poor. Explanation of these discrepancies is speculative.

40968 (SAND—79-0740C) **Prompt burst energetics (PBE) studies.** Reil, K.O.; Young, M.F. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 16p. (CONF-790429—2). Dep. NTIS, PC A02/MF A01.

From 4. specialist meeting on fuel-coolant interaction in nuclear reactor safety; Bournemouth, UK (2 Apr 1979).

These studies involve an in-pile experimental program and complementary analytical investigation of the energetic response of important reactor fuel-clad-coolant systems subjected to energy deposition conditions associated with super-prompt critical excursions. The objectives of the present program include identification and characterization of the phenomena which dominate the conversion of thermal energy to work, development of models which accurately predict the energetics associated with such hypothetical accidents, and provision of the necessary input data for those models. This program includes the examination of the integral effects of fuel-clad-coolant interactions, fission gas release, and fuel and fission product vapor pressure during super-prompt critical core disruptive conditions, and thus, serves to define the initial conditions for hydrodynamic expansion of the disrupted core. Progress to date is summarized.

40969 **Nuclear systems reliability engineering and risk assessment.** Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977). 860p. (CONF-770625—).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

Separate abstracts were prepared for the individual papers presented at the meeting.

40970 **Prospects and problems in risk analyses: some viewpoints.** Levine, S.; Vesely, W.E. (Nuclear Regulatory Commission, Washington, DC). pp 5-21 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

Present problem areas in risk analysis are outlined and promising utilizations are described. Some of the specific problems involve lack of standardization of models, data, and quantitative approaches. The promising areas include performances of generic analyses and sensitivity evaluations. Specific applications being performed within the U. S. Nuclear Regulatory Commission are described.

40971 **Application of probabilistic methods to safety R and D and design choices.** Gavigan, F.X.; Griffith, J.D. (Energy Research and Development Administration, Washington, DC). pp 22-41 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

The Liquid Metal Fast Breeder Reactor (LMFBR) safety program is committed to identifying and exploiting areas in which probabilistic methods can be developed and used in making reactor safety R and D choices and optimizing designs of safety systems. Emphasis will be placed on a positive approach of solidifying and expanding our knowledge. This will provide the groundwork for a

consensus on FBR risk. The management structure which will be used is based on a mechanistic approach to an LMFBR Core Disruptive Accident (CDA) with risk partitioned into "Lines of Assurance," i.e., independent, phenomenologically-based barriers which will impede or mitigate the progression and consequences of accident sequences. Quantitative determination of the probability of breach of these barriers through the completion of work identified for each Line of Assurance will allow the quantification of the contribution to risk reduction associated with the success of each barrier. This process can lead to better use of resources by channeling R and D in directions which promise the greatest potential for reducing risk and by identifying an orderly approach to the development and demonstration of design features which will keep LMFBR risks at an acceptable level.

40972 Relationship between risk assessment and reliability requirements. Farmer, F.R. (United Kingdom Atomic Energy Authority, Warrington, England). pp 42-55 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

Many accidents have occurred and have assisted the development of many industries. Now some are called disasters, examples are given. We cannot avoid all accidents and need to consider some degree of improbability. Accepting limitations in knowledge and its use, the problem is how best to anticipate and reduce the risk of accident. Research is required to provide background basic knowledge and to establish some data base. Many assessments of systems, or pressure vessel behavior or emergency cooling provisions proceed on a step by step basis: the logical process variously called event or fault trees. After some review of current objections to risk/consequent assessment the paper considers the current topic of risk acceptability and leads into nonacceptability as a more favored route. The paper concludes with some discussion of individual and large scale societal risks in industrial activities.

40973 Social aspects of risk assessment. Otway, H.J. (International Atomic Energy Agency, Vienna, Austria); Linnerooth, J.; Niehaus, F. pp 56-79 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

Plans for technological development have often been met by demands for a closer examination of the associated benefits and risks and the consideration of social values in public planning and decision processes. A theoretical framework for inter-disciplinary risk assessment studies is presented to aid the balancing of technical data with social values in decision making. Methods for obtaining value measures are reviewed and an attitude-based method is developed in detail; this model allows identification of the relative importance of the technical, psychological and social factors which underlie attitudes and indicates which factors differentiate between social groups. Results of a pilot application to nuclear power are summarized. For these subjects, different attitudes between pro and con were primarily due to strongly differing beliefs about the benefits of nuclear power. Preliminary results are reported of an application of this model with a heterogeneous sample drawn from the general public. The cognitive limitations which affect rationality in intuitive decision making are summarized as background to introduce formal decision methodologies for the use of attitude data in public decision making.

40974 Reliability modelling of electrical auxiliary systems in nuclear power stations. Billinton, R. (Univ. of Saskatchewan, Saskatoon); Allan, R.N.; Deoliveira, M.F. pp 219-241 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

The electrical auxiliary system in a nuclear power station is a complex configuration involving transformers, load buses protection and isolation devices, normally closed and normally open paths, stand-by and parallel redundancy and a multitude of individual loads. The availability of the various loads can have a considerable influence on the generating unit and station output. This paper illustrates the development and application of a quantitative technique for evaluation of the adequacy of a typical nuclear station electrical auxiliary system.

40975 Determination of initiating events and sequences of reactor accidents by a barrier analysis. Carnino, A.; Dubau, J. pp 242-262 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

From a barrier analysis (fuel cladding, primary circuit, containment), a systematic search for the potential initiating events and the accident sequences is conducted. The method is divided into three parts: (1) The barrier analysis: For each barrier, an event tree is constructed having for top event the barrier loss. (2) The search for initiating events of accidents (an accident has occurred when all the barriers are broken or failed). (3) Accidents events trees: From an initiating event, the accident sequence is derived. To illustrate the method, the failure of all the electrical power supplies in a 900 MW PWR is considered. Possible extensions of the method to other risks are suggested.

40976 Diversity and periodic testing in defense against common mode failure. Epler, E.P. pp 269-288 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

The probability of failure to scram has been estimated to be as high as 10^{-4} per reactor year; WASH 1270 had proposed that this be improved to 10^{-7} per reactor year. To accomplish this both the application of diverse shutdown systems and frequent periodic testing have been proposed. An examination of a number of systemic failures which have occurred in both development reactors and current LWR's leads to the conclusion that operator perversity continues to be a dominant mechanism leading to failure. Conditions are thereby established which cannot be anticipated by the designer, with the result that limited improvement would be gained through the application of diverse systems.

40977 Common cause failure analysis methodology for complex systems. Wagner, D.P.; Cate, C.L.; Fussell, J.B. pp 289-313 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

Common cause failure analysis, also called common mode failure analysis, is an integral part of a complex system reliability analysis. This paper extends existing methods of computer aided common cause failure analysis by allowing analysis of the complex systems often encountered in practice. The methods presented here aid in identifying potential common cause failures and also address quantitative common cause failure analysis.

40978 Estimating common cause failure probabilities in reliability and risk analyses: Marshall—Olkin specializations. Vesely, W.E. (Nuclear Regulatory Commission, Washington, DC). pp 314-341 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

The Marshall—Olkin approach to common cause failures is specialized to repairable situations where components have similar susceptibility to common cause mechanisms. Two cases are developed, the CFR case and the BFR case, which allow recorded failure data to be efficiently utilized in estimating common cause failure probabilities. The BFR case is applied to Boiling Water Reactor (BWR) scram failure data to estimate probabilities of multiple control rods failing.

40979 Stochastic models for repairable redundant systems susceptible to common mode failures. Chu, B.B.; Gaver, D.P. (Electric Power Research Inst., Palo Alto, CA). pp 342-367 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

Redundant protective engineering systems are in principle susceptible to chance and common mode failures. The intent of this paper is to propose two Markov models which recognize both chance and common mode failures in quantifying system performance. These models have possible usefulness in common failure calculations in nuclear reliability and risk analyses. Model 1 incorporates chance failures and common mode failures of a catastrophic

nature. Model 2 assumes that the common failure mode mechanisms increase the failure rates of the components. Solution methods for these two models are summarized, and some results are also given to illustrate the effects of common failure mode on the mean-time-to-system-failure and the system survival probabilities.

40980 Application of risk analysis: functional relationships of nuclear risks. Maekawa, M. (Massachusetts Inst. of Tech., Cambridge); Vesely, W.W.; Rasmussen, N.C. pp 375-394 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

A method is developed for deriving an explicit set of equations relating the public risk in potential nuclear reactor accidents to more basic variables, such as population distribution and radioactive releases. The methodology consists of two steps. The first step involves parametrically fitting the risk distributions of frequency versus consequence. The second step involves relating the distribution parameters to the basic variables of interest. Regression techniques are used for this second step. The methodology is demonstrated on examples based on the results of the Reactor Safety Study (WASH 1400). The calculated distributions of early fatalities in nuclear reactor accidents and the historical records of fatalities in hurricanes, tornadoes, earthquakes and dam failures are examined to determine an appropriate family of parametric distributions. From these examinations, the Weibull distribution is found to be appropriate for all of the examined events. A set of equations is then derived which relates the population distribution and the parameters of the Weibull distributions for early fatalities from PWR accidents. The derived equations are useful in analyses of population effects on risk. Regression equations relating the parameters to the characteristics of radioactive releases are also derived. The derived equations are useful for evaluating release effects on risk.

40981 Probabilistic approaches to advanced reactor design optimization. Burdick, G.R. (EG and G Idaho, Inc., Idaho Falls, ID); Rasmuson, D.M.; Weisman, J. pp 395-417 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

Approaches to advanced reactor design which combine probabilistic methods with system optimization techniques are proposed. In recognition that the best available design and manufacturing methods have been applied to component design and manufacture, it is suggested that significant improvement of nuclear systems performance is possible only through modification of the systems configuration. Thus, the models used in the optimization procedures are those for redundancy and diversity allocation or models which provide goals for such allocation. It is shown that diversity and redundancy allocation may be improved through the construction and use of functions which represent an estimate of the best cost obtainable for a given level of system availability. The use of functional relationships between cost and availability is extended to the case where acceptable levels of risk have been defined for plant operation. In this case, the cost functions for the various safety systems are used to form an overall objective function. Societal risk expressions are formulated in terms of safety system unavailabilities. Construction of the cost objective function and risk expressions constitutes completion of the top-level problem. A second-level problem is then solved which performs trade-offs of cost and availability among the safety systems. The second-level problem solution is a set of availability goals and cost guidelines which can be used by designers in solution of third-level problems which are determinations of the actual safety system configurations.

40982 Procedure for the use of probabilistic risk assessments to establish ranking of research and development goals. Temme, M.I.; El-Sheikh, K.A. (General Electric Co., Sunnyvale, CA). pp 418-442 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

A procedure for Ranking Research and Development goals on the basis of their importance to risk is described. Using information developed in a typical LMFBR risk assessment, rules for selection of the most important events or groups of events (e.g., event sequences) are defined. The procedure is illustrated through its application to an example, using a First Cycle Risk Assessment of FFTF.

40983 Concept for the reliability assessment of the containment of a PWR. Schueeler, G.I. (Univ., Munich, Germany). pp 443-464 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

A concept for the reliability assessment of the Containment of a PWR based on classical statistics is presented. The statistical nature of various external hazards such as earthquakes, external pressure waves, aircraft crashes, as well as internal load conditions such as the LOCA are discussed. The key problem, which is the establishment of the relation between the time-dependent frequency of occurrence of the hazards and their intensity, is discussed in light of their rare event property. For this reason the Poisson process is used as prediction model. The intensity distributions of the Fisher—Tippett type. Various failure modes such as fracture and the yield condition and their influence on the design are discussed. The work concludes with a numerical example in which the reliability of the steel hull of a sample containment structure under a large LOCA is calculated.

40984 Probabilistic analysis of accidental transients in nuclear power plants. Amesz, J. (CEC Joint Research Centre, Ispra, Italy); Garribba, S.; Volta, G. pp 465-487 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

The aim of this work is to establish a theoretical frame for computing probability distribution of loads and residual strength in the primary cooling system of nuclear power reactors. Random point processes provide a sufficiently general frame for describing operational and accidental load transients. Once failure modes have been ascertained and a failure hypothesis has been established, strength appears represented by a filtered process and reliability can be in principle computed. Information concerned with failures and performance characteristics of components allows us to infer the statistical structure of the random processes. The case is displayed where advantage is taken of all information which is available prior to the design. The case is then considered where use is made of additional data obtained through operation practice of the system.

40985 Risk/cost assessment of administrative time restrictions on nuclear power plant operations. Henley, E.J. (Univ. of Houston, TX); Polk, R.E. pp 495-517 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

This paper analyzes the effect of varying administrative time restraints on plant availability and the attending risk and economics of continued plant operation. The approach involves a Monte Carlo simulation to predict plant availability with variations in operating restrictions due to degraded safeguard systems. The model provides information on the cost of plant outages. The results from an extensive study on the risks associated with the operation of commercial power reactors are then coupled with the results of the simulation to form the basis of a risk-cost comparison. From this comparison, observations and recommendations can be made as to the viability of relaxing such restrictions. A DC power system for a pressurized water reactor plant is used for the simulation and risk study.

40986 Recent advancements in fault tree methodology at Karlsruhe. Caldarola, L.; Wickenhaeuser, A. (Gesellschaft fuer Kernforschung, Karlsruhe, Germany). pp 518-542 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

A very fast analytical computer program for fault tree evaluation has already been developed at the German nuclear research center of Karlsruhe. This program can evaluate coherent systems assuming binary component states. Four different classes of components can be handled by the program: (1) unrepairable components, (2) repairable components with revealed faults, (3) repairable components with faults remaining unrevealed until next demand occurs and (4) repairable components with faults which are detected upon inspection. The program can perform also time dependent calculations. In particular the program can analyse systems characterized by two phases, one following the other in time (two time axis). A new computer program is also being developed. This computer

program will be capable to analyse noncoherent systems with multistate components. The mathematical theory supporting the new program is described in the paper. In particular the algorithm for the identification of the prime implicants and the theory for the calculation of the occurrence probability and of the first occurrence probability of the TOP event are discussed.

40987 Analysis of time between failures for repairable components. Barlow, R.E.; Davis, B. (Univ. of California, CA). pp 543-561 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

A method for analyzing time between failure data is developed. The method uses total time on test plots for a nonhomogeneous Poisson process failure method. Engine failure data is used to illustrate the method. A graphical method for determining optimum replacement intervals is presented.

40988 Effect of modeling depth on reliability prediction for systems subject to a phased mission profile. Esary, J.D. (Dept. of Operations Research, Monterey, CA). pp 562-583 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

The term "phased mission profile" describes a situation in which the factors that influence the longevity of a system change in the course of a sequence of distinct, successive periods of time which are the mission "phases." Phased mission profiles tend to be associated with more general phased missions, in which there can also be changes in the system configuration that is relevant to mission success, but many systems with a stable configuration are exposed to phased mission profiles. Predictions of the probability of mission success for a system typically result from combining predicted probabilities of mission success for its components according to a logic model for the system's configuration. We investigate the effect that the depth to which the logic model is carried has on predictions, when the predictions at the component level are made using a "standard" methodology.

40989 Defect analysis program applied to nuclear plant experience data. Crellin, G.L.; Jacobs, I.M.; Smith, A.M. (General Electric Co., Sunnyvale, CA). pp 611-635 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

This paper deals with the initial phase of a development program for Defect Management in the design, construction and operation of nuclear power plants. The program objective is to capitalize on existing operating experience to form a basis for "lessons learned" applications to future nuclear power plant systems.

40990 Reliability assessment of nuclear systems with reference to safety and availability. Green, A.E. (United Kingdom Atomic Energy Authority, Culcheth, England). pp 661-685 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

This paper concerns the evaluation of the reliability of nuclear plant systems which usually depends upon some form of prediction. This applies at the early design stage when the overall system is being formulated. Some of the systems are dominated in their design and concept by safety considerations. However, not only must the reactor plant be shown to be adequately safe but also it must be capable of performing its operational role when required to do so. The paper discusses some of the experience and results of carrying out reliability assessments in connection with the evaluation of safety and the availability of these systems.

40991 Role of reliability and risk assessment in LMFBR design: implementation of reliability in LMFBR design. Graham, J.; Zemanick, P.P. (Westinghouse Electric Co., Madison, PA). pp 686-709 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

This paper better concerns future developments in LMFBR licensing technology. Federal Regulations (10 CFR 50.34) require that the preliminary safety analysis provide analysis and evaluation "with the objective of assessing the risk to public health and safety" to determine margins of safety and the adequacy of the plant. Hitherto, the assessment of risk has been qualitative but it has become increasingly apparent that quantitative assessments would provide a better basis for judgement. Potential future roles of reliability and risk assessment are discussed in the context of providing additional confirmation of the safety of LMFBR designs. Potential acceptability criteria for risk evaluations are outlined. The reliability implications of designing components to the ASME Code Section III requirements are discussed. General judgements are provided as well as the preliminary results of probabilistic studies of selected specific limits. There is a different reliability significance for the mandatory rules for normal, upset, and emergency conditions versus the non-mandatory rules for normal, upset, and emergency conditions versus the non-mandatory guidance for faulted conditions.

40992 Method for quantifying logic models for safety analysis. Erdmann, R.C.; Kelly, J.E.; Kirch, H.R.; Leverenz, F.L.; Rumble, E.T. (Science Applications, Inc., Palo Alto, CA). pp 732-754 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

The accomplishment of any detailed reliability or risk analysis task involves both engineering judgement and accurate analytical procedures. In this paper procedures are described which have been programmed so that a variety of information concerning reliability, availability, risk assessment, and cost impact can be evaluated quickly and accurately. Utilizing a common input deck the WAM codes efficiently and accurately provide information about systems modeled by any Boolean function. This information includes: (1) Point estimates of the system (top event) reliability (or unreliability) together with the reliability of any event within the system (WAM-BAM code). (2) A reevaluation of the system as described in (1) with changes made to the probability of occurrence of basic events (WAM-TAP code). (3) Qualitative assessment of the system in term of failures (cut-sets) which cause the system to fail and which cause any event within the system to occur (WAM-CUT code). (4) Qualitative assessment of the system and events within the system together with the first, and if desired, second moment of the probability of the events being analyzed. This allows modeling the basic system components as random variables with a mean and standard deviation included in the model (WAM-CUT code). (5) Qualitative assessment of the system which is displayed in terms of cut sets and the probability polynominal (WAM-CUT code). This can be stored for use by a Monte Carlo code which allows determination of the distribution of the system reliability as a function of component distributions (SPASM code). (6) A drawing of the fault tree as input to the evaluation codes (WAM-DRAW). This paper will describe the development of these codes and present example problems which illustrate the codes' capabilities.

40993 Experience with algorithms for automatic failure analysis. Taylor, J.R.; Hollo, E. (Research Establishment, Riso, Denmark). pp 759-774 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

A brief review of the work carried out at Riso from 1973 to 1977, with the objective of constructing fault trees and cause-consequence diagrams automatically is presented.

40994 Synthesis of fault trees. Lapp, S.A.; Powers, G.J. (Carnegie-Mellon Univ., Pittsburgh, PA). pp 778-799 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

In order for fault tree analysis (FTA) to be useful in the assessment and control of risk, the synthesis of the trees should be: 1) routine - so that project engineers, etc. will use it. 2) rapid - so that it won't slow down the project. 3) accurate - so that the results will have some meaningful relationship to the actual risk. 4) flexible - so that the synthesis procedure could be used on a wide range of systems. We present an algorithm which uses directed graph (digraph) models of the cause and effect relationships between variables

and events. Given the models, the algorithm will deduce the combinatorially correct fault tree for the system. The models and the algorithm are described and tested on two examples.

40995 Use of decision tables in the systematic construction of fault trees. Wu, J.S. (Univ. of California, Los Angeles); Salem, S.L.; Apostolakis, G.E. pp 800-824 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

A systematic methodology for the construction of fault trees is presented based on the use of decision tables. These tables are used to described each possible output state of a component as a complete set of combinations of states of inputs and internal operational or failed states. The methodology has been implemented by the development of a computer code, which, following several stages of editing, produces a fault tree in conventional format. The analysis of an actual reactor system using this methodology is presented which demonstrates the applicability and flexibility of the approach.

40996 Use of the GO methodology to directly generate minimal cut sets. Williams, R.L.; Gateley, W.Y. (Kaman Sciences Corp., Colorado Springs, CO). pp 825-849 of Nuclear systems reliability engineering and risk assessment. Fussell, J.B.; Burdick, G.R. (eds.). Philadelphia, PA; Society for Industrial and Applied Mathematics (1977).

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

The set of computerized algorithms called "GO" for operating upon the logic models created in system reliability analyses has been established as an efficient and economical procedure. Recent developments have extended its capability to generate minimal cut sets. This is accomplished by retaining the original sequential computer generated model information, selecting an output event of interest, assigning response modes to each operator and inverting the original GO process to ascertain operator response mode combinations inducing the selected event. The original GO model can thus be used to generate minimal cut sets to the fourth order which lead to system events of interest.

ACCIDENT LIABILITY

40997 (INIS-mf—4613) **Recent developments in the European nuclear insurance scene.** Francis, H.W. (British Insurance (Atomic Energy) Committee, London). 1978. 5p. (CONF-780584—13). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on regulating nuclear energy; Brussels, Belgium (16 May 1978).

Despite the development of a strong anti-nuclear feeling in Europe, the nuclear programme in the main European countries has not been stopped. The European insurance market has evolved considerably and the liability limits have been raised in several countries. Insurers must face the twin problem of increased insurance capacity to cover material damage, as well as the higher liability amounts for operators of nuclear installations in certain countries.

40998 (INIS-mf—4614) **Nuclear liability insurance problems and trends as seen by the European utilities.** van Gulck, A. (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1978. 10p. (CONF-780584—14). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on regulating nuclear energy; Brussels, Belgium (16 May 1978).

After recalling the basic principles of nuclear civil liability conventions, the author describes the different types of damage presently covered by nuclear insurance. Also, a Study Committee was created in Western Europe in 1974 to examine the possibility of setting up a mutual pool to cover risks such as fire and property damage in nuclear installations. In the immediate future machinery breakdown and all risk coverage on-site will not be covered. This mutual pool will widen the nuclear insurance market in the coming decades.

40999 (INIS-mf—4625) **International nuclear liability conventions: status and possible changes.** Reyners, P. (Nuclear Energy Agency, 75 - Paris (France)). 1978. 21p. (CONF-780584—15). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on regulating nuclear energy; Brussels, Belgium (16 May 1978).

The table of ratifications and accessions annexed to this paper shows that despite the considerable progress achieved these past years and the entry into force of the Vienna Convention, the number of Contracting Parties to the Nuclear Civil Liability Conventions remains insufficient. The adaptation of the first of these Conventions - the Paris Convention - as well as its Brussels Supplementary Convention to the technical and economic developments which have taken place since their adoption should provide the means for encouraging their implementation at international level. The main amendments which are envisaged are replacement of the present unit of account by the Special Drawing Right, the increase of the amounts of liability and compensation and finally, the technical scope of the Paris Convention.

ENERGY STORAGE

REFER ALSO TO CITATION(S) 41044, 41179

FLYWHEELS

REFER ALSO TO CITATION(S) 41335

41000 Whirling response and stability of flexibly mounted, ring-type flywheel systems. Chen, L.C.T. Norman, OK; Univ. of Oklahoma (1978). 121p. University Microfilms Order No. 79-08,816.

Thesis (Ph. D.).

The scarcity and rising cost of petroleum have motivated international interest in developing hybrid automobiles using flywheels for mechanical energy storage. Rim-type composite-material flywheels are promising designs for such developments. These flywheels significantly differ from turbine/compressor systems in two respects. First, the flywheel rim attachment to its hub is very flexible, for both translation and tilting. Secondly, these flexibilities depend upon rotational speed through centrifugal stiffening. Free whirling, stability, and forced whirling are examined for these flywheel systems. The numerical results presented are most directly applicable to the Sandia single-rim systems currently under development. However, the present analyses can be extended to other flywheel designs within the broad category of the rim type. In the free-whirling analysis, predicted critical speeds are encountered in the design operating speed range. Practical ways to increase such critical speeds are suggested. Effects of material internal damping on the stability of the system are incorporated through adopting complex moduli in the formulation. It is found that the adverse effect of internal damping on the onset of instability can be overcome by providing an adequate external damper up to a considerably high speed. Forced whirling excited by unbalance and initial tilt of rim element is studied. Minimum external damping is determined such that the maximum response does not exceed a permissible value.

THERMAL

REFER ALSO TO CITATION(S) 40574, 40575, 41147

41001 (CONF-790345—1) **Modeling for moving boundary problems.** Solomon, A.D. (Union Carbide Corp., Oak Ridge, TN (USA). Nuclear Div.). 1979. Contract W-7405-ENG-26. 20p. Dep. NTIS, PC A02/MF A01.

From Workshop on solar energy storage; Chandigarh, India (9 Mar 1979).

The classical problems in partial differential equations involve solving an equation within a fixed spatial region. However, when attempting to model such phenomena as melting and freezing, we find that as time varies the region in which, e.g., material in the liquid phase is present, will also vary and must be determined. Such problems, for which the solution of a partial differential equation is sought in a region which is itself varying in an unknown manner, are referred to as moving boundary problems. The current state of the art of moving boundary problems as it applies to the storage of heat as latent heat is described.

41002 (EPRI-EM—1037(Vol.1)) **Conceptual design of thermal energy storage systems for near-term electric utility applications. Volume 1: screening of concepts.** Hausz, W.; Berkowitz, B.J.; Hare, R.C. (General Electric Co., Schenectady, NY (USA)). Apr 1979. Contract EC-77-A-31-1034. 269p. Dep. NTIS, PC A12/MF A01.

The methodology and results of the system selection task in a continuing study of thermal energy storage (TES) concepts for near-term application with utility steam/electric power plants are discussed. Over 40 TES concepts and variants were considered for possible use with representative coal-fired and nuclear power plant designs. Preliminary screening reduced the field to 12 selections. Cost and performance estimates were made for integrated TES/power plant systems and combined with judgments of technical risk,

near-time availability, conservation potential, ect., to select the following four systems for further study: (1) HTW storage in a lined underground cavity as applied to a coal-fired plant to generate additonal steam; (2) dual-media heat storage (oil/rock or molten salt/rock) as applied to a coal-fired plant to generate additional steam; (3) preheated feedwater storage in prestressed cast-iron vessels as applied for feedwater heating in a nuclear plant to reduce extraction of turbine steam; and (4) dual-media heat storage as applied for feedwater heating in a nuclear plant to reduce extraction of turbine steam. Further study of these four TES/power systems will include: (1) development of more-detailed conceptual designs, with corresponding cost and performance estimates; (2) a benefit analysis, to consider utility system characteristics, economics, conservation potential, etc;and (3) if warranted, outlining of a recommended development and near-term demonstration program. (TFD)

41003 (EPRI-EM—1037(Vol.2)) **Conceptual design of thermal energy storage systems for near-term electric utility applications. Volume 2. Appendixes: screening of concepts.** Hausz, W.; Berkowitz, B.J.; Hare, R.C. (General Electric Co., Schenectady, NY (USA)). Apr 1979. Contract EC-77-A-31-1034. 151p. Dep. NTIS, PC A08/MF A01.

Vol. 2 contains three appendices entitled: (A) Bibliography and Cross References; (B) Taxonomy: Proponents and Sources; and (C) Concept Definitions. (TFD)

41004 (N—79-10517) **Thermal energy storage subsystems. Quarterly reports, 1 January—30 June 1978.** (Artech Corp., Falls Church, VA (USA)). Jan 1978. Contract NAS8-32254. 17p. NTIS PC A02/MF A01.

Progress made in the development, fabrication, and delivery of thermal energy storage, are discussed.

BATTERIES

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 41006

41005 (BMFT-FB-T—77-88) **Development of electrochemical storage batteries with improved energy density.** Beck, F.; Treptow, W. (BASF A.G., Ludwigshafen am Rhein (Germany, F.R.)). Jun 1976. 208p. (In German). Dep. NTIS (US Sales Only), PC A10/MF A01.

An introductory survey is given on the possibilities of storing electrical energy via electrochemical energy storers and on the principles of so-called solution accumulators, whereby the common lead accumulator is in particular compared with the lead tetrafluoroborate solution accumulator. HBF_4 acids containing lead salt are electrochemically investigated for the complete Pb/PbO_2 system, the lead solution electrodes regarding their current—voltage curves and corrosion behaviors, and the PbO_2 solution electrode regarding cyclic charge—discharge curves, current—voltage curves, influence of the base electrode material and electrolyte additive, corrosion, and reaction mechanism. Furthermore, a report is given on cycling tests and different charge—discharge conditions and cell systems. Energy and power densities obtainable are estimated as well as the importance of electrolyte convection. Technical and economic aspects of the lead tetrafluorborate solution accumulator are discussed. Finally, the results are compared with the alternative solution accumulators: Zn/MnO_2, Pb/MnO_2, Cu/PbO_2, Zn/PbO_2, and Pb/chloranil.

PERFORMANCE AND TESTING

41006 (N—79-10527) **Sealed silver-oxide—cadmium batteries for space flight, 1960—1977.** Hennigan, T.J. (Hennigan (Thomas J.) Associates, West Hyattsville, MD (USA)). Apr 1978. 298p. NTIS PC A13/MF A01.

A technical summary of design, development, and test activities with silver oxide—cadmium batteries at the Goddard Space Flight Center since 1960 is given. The flight experience of over 15 missions has demonstrated the sealed silver oxide—cadmium Battery to be a viable energy storage device for missions requiring ultra-clean magnetic environment.

ENERGY MANAGEMENT AND POLICY

41007 (DOE/EIA—0149) **EIA Publications Directory.** Noble, D.L. (Department of Energy, Washington, DC (USA). Energy Information Administration). Jan 1979. 70p. Dep. NTIS, PC A04/MF A01.

In this first Directory of publications published under the auspices of the EIA, can be found descriptions of the contents and data displayed within 140 special-purpose and one-time reports, Analysis and Technical Memoranda, maps, and periodicals. Ordering information for all publications (produced through December 31, 1978) is included. Five discontinued publications are listed.

41008 (UCRL—15000) **Problems of social organization in California's energy industry: lessons from the present and considerations for a distributed future.** Bradshaw, T.K.; Eagle, E.; Cook, N. (California Univ., Berkeley (USA). Inst. of Governmental Studies). Dec 1978. Contract W-7405-ENG-48. 65p. Dep. NTIS, PC A04/MF A01.

This report presents the initial findings of a research effort into the structure of California's electrical and gas utilities and the petroleum industry in terms of the organizational structure of these sectors. These data were collected and are reported in order to show some of the important organizational characteristics that today affect the energy industry and to anticipate the organizational opportunities and liabilities of potential future distributed technologies. Data are presented on four organizational characteristics (integration, centralization, interdependence, and public involvement) of the California energy system and the implications of these characteristics are illustrated with examples from a consideration of the likely organizational structure for two alternative technologies which might contribute to a distributed energy future for California. Data were collected on every California energy organization, but was specifically concentrated on about 20 electrical companies, 8 gas companies, and the major petroleum refiners. (MCW)

41009 **Energy use management.** Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978). 1148p. (CONF-771009—P3andP4). Pergamon Press Inc., Fairview Park, Elmsford, NY 10523.

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

A separate abstract was prepared for each of the 124 papers of this volume that were presented at the conference. All of the abstracts will appear in Energy Research Abstracts (ERA); 119 were selected for Energy Abstracts for Policy Analysis (EAPA). Two papers are cited in the volume with only the abstracts included. For the first two volumes, CONF-771009—Pt. 1 and Pt.2, see EAPA 4: 1962 and 1691. (MCW)

ENERGY ANALYSIS AND MODELING

REFER ALSO TO CITATION(S) 41028, 41029, 41089, 41091, 41093, 41109, 41110, 41119, 41154, 41156

41010 **Detailed energy accounting and its role in the development of a commercially viable coal-conversion industry.** Peters, W.C.; Schwartz, D.L.; Ruppel, T.C. (Pittsburgh Energy Research Center, PA). pp 97-107 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The commercial viability of a new industry is traditionally assessed in terms of economics, environment, and energy efficiency, in descending order of importance. Energy efficiency is beginning to take on added relative importance, especially for emerging industries. Energy and its relationship to environmental and cost considerations are discussed in conjunction with the analysis of energy efficiency of the coal conversion industry. Detailed energy accounting (DEA), in the form of extensive energy requirement audits and surveys, which include thermodynamic second law availability data, is emerging as a useful technique to identify, document, and assess the relative merits of the opportunities for improved energy-utilization efficiency in existing industries. The DOE, Pittsburgh Energy Research Center has developed an energy-efficiency evaluation methodology and is building a detailed energy requirements and availability data base for coal-conversion processes.

41011 **Energy audit: what it is, how to conduct it, how to use the results.** Snyder, W.T.; Symonds, F.W. (Univ. of Tennessee, Knoxville). pp 109-119 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

This paper describes some of the practical aspects of the energy audit as the principal element of an energy-management program. The energy audit consists of two phases, the first phase involving the accumulation and analysis of energy use and production records, and the second phase involving an on-site, walk-through audit of the faciity. The energy audit leads to an identification of potential energy-conservation opportunities (ECO's). A systematic procedure is described for analyzing the potential energy

and cost savings of an ECO as well as a first-level economic analysis of payback period for various levels of capital investment required to implement the ECO.

41012 AXCESS energy analysis and its applications. Mehta, L.; Douglass, E.S. (S and H Information Systems, Inc., New York, NY). pp 229-239 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The AXCESS programs consist of two main parts: Energy Analysis and Financial Analysis. While AXCESS Financial Analysis is designed primarily for the engineer who desires to use more advanced life-cycle-costing methods, this paper discussed the AXCESS Energy Analysis computer programs. The AXCESS Energy Analysis computer program is a computerized method for comparing the energy requirments of alternate mechanical/electrical systems in buildings. It allows the designer to compare energy usage and where applicable, energy demand for each such system using any combination of available energy sources. Basic input to AXCESS consists of one year of hour-by-hour weather data for the specified geographical location, building dimensional and schedule information, type selections, and design parameters for major HVAC system components and the magnitudes and operating profiles for other non-HVAC energy-using device in the building. Additional refinements such as waste-heat capture and utilization may also be included. The final task in the input procedure is to specify meters to which each energy-utilizing device in the building should be connected. The areas of potential application within the field of energy management is broadly categorized as new and existing buildings and specialized studies (gaining an insight into how various energy systems respond to variations in the design and operating parameters and for analyzing the energy performance of new equipment to assess their marketability).

41013 TRACE Version 200 series and TRACE solar. Bridges, D.R. (Trane Co., La Crosse, WI). pp 241-250 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

An overview of the third-generation TRACE Program, currently TRACE Version V204, is given. TRACE allows energy and energy-related economic aspects of a building to be considered. These include its architectural design, its systems, its equipment, its utilization, and its economic goals. The system and its operation are discussed in detail. TRACE is a comparative-analysis tool that will quantify energy-savings potential and energy dollars that can be saved through existing building renovation for each individual energy conservation idea. It is a tool to assess the energy and economic impact of change to existing buildings. The Trane Company has also developed a means for building and system designers to become proficient in energy analysis for the minimum investment of time and money. This means is the TRACE-DIRECT Program. TRACE SOLAR is a completely independent stand-alone program that can simulate combined building HVAC systems and solar collector operation. The program calculates and compiles building requirements for cooling, heating, and hot water in the system simulation phase. These are passed to the solar phase which is a program capable of analyzing solar collector performance. (MCW)

41014 CAL-ERDA, a new computer program for building energy analysis. Winkelmann, F.C. (Univ. of California, Berkeley); Lokmanhekim, M.; Mitchell, H.C.; Rosenfeld, A.H.; Graven, R.M.; Hunn, B.D.; Cumali, Z. pp 251-265 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

CAL-ERDA, a new public-domain computer program for building energy analysis, features ease of input and fast algorithms. Fast, flexible input is made possibly by a simulation input language known as Building Design Language (BDL). A selection of predefined HVAC distribution systems and primary equipment is available to the user. The fundamentals of BDL are illustrated by discussion and examples. Calculations of hourly LOADS, SYSTEMS, PLANT, and ECONOMICS for a full year of weather data on multi-zoned buildings typically use less than fifty thousand words of core, required 2 to 4 CPU seconds per zone, and cost less than $1.00 per zone on the CDC 7600 computer at LBL.

41015 Energetics of managed land-use systems. Klopatek, J.M. (Oak Ridge National Lab., TN). pp 549-558 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Natural systems have evolved to use solar energy in conjunction with available materials and water. When man converts these natural systems to man-managed systems (e.g., agriculture, plantation forestry) an initial cost expenditure is required as well as a continual or periodic maintenance cost. Therefore, both the inputs and the outputs, as well as the internal structure, of these managed systems differ from the natural systems. Through application of energy-flow-analysis methodology, the cost and benefits associated with different land uses can be quantified with the common denominator of kcal fuel equivalents. This approach has been utilized to quantify the energetics of maintaining various land-use types in different physiographic regions. Macroscale energy models were constructed and the inputs and outputs of these land-use systems (agriculture, grazing land and intensive forestry) quantified in terms of fuel equivalents. The results show that the energy costs of maintaining some of these systems in certain areas may be economically beneficial in the short run, but energetically prohibitive in the long run. This results from large energy subsidies required to overcome the natural limiting factors. Energy efficiency of natural systems is significantly greater than that of the managed systems, although the harvestable productivity is lower. A comparison of the cost/benefits of the natural systems prior to managed systems is made, and a case is made for preservation of energy-efficient cropland from irretrievable commitment to other land-use types.

41016 Energy costs of corporate dislocation. Hart, F.C. (Fred C. Hart Associates, Inc., New York, NY). pp 761-767 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The recent movement of corporate headquarters and major facilities from New York City is discussed. The movement to suburban facilities costs at least 25,000 gallons of gasoline annually for every 100 jobs moved, due to a shift from the public transit of urban centers to the automobile-dominated commuting of suburbs and smaller urban centers. Corporate headquarters provide managerial services across a worldwide network, drawing back to urban centers the economic resources that are required for corporate upkeep. Thus, the corporate headquarters represent a mainstay for numerous service industries, such as printers, equipment installers, financial specialists, travel agents, and others. These industries also tend to migrate. The efficiency of public services such as transit automatically decline as the public usage is withdrawn. Each of these changes exacts an energy cost. At a deeper economic level, the movement of corporate headquarters has dealt urban centers a shock. Corporate headquarters had been identified as the most promising type of future employer and tax payer. These were the industries that had to locate where communication lines converged and face-to-face meetings for corporate business could occur. When large numbers of corporations move, a city's natural advantage is depleted. The critical mass eventually disappears, reducing the incentive for other corporations to remain. With each move, energy use increases. This paper focuses upon the additional energy consumption that can be attributed to the movement of corporations from New York City in recent years. The historical background is briefly reviewed to give the reader an idea of the general dimensions of the movement. Then the categories of energy use are described and estimated.

41017 Mathematical modeling of the influence on environment of developing countries in a world economy dominated by industrial nations. Plass, H.J. Jr. (Univ. of Miami, Coral Gables, FL). pp 931-939 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

A two-region mathematical model of the world is constructed in which Region 1 consists of the developed nations and Region 2 consists of the undeveloped countries. Fuel resources from Region 2 are supplies to Region 1 in exchange for products and technology to Region 2. The price for imported fuel is assumed to be high enough to allow Region 2 to have a more rapid rate of economic growth than Region 1. The model includes energy, economic, and environmental effects in both regions, and approximately predicts the combined effluent to the global environment as a function of time for different amounts of pollution control applied in Region 1. Results indicate that, in spite of a more rapid growth rate for Region 2, the primary responsibility for pollution management is with Region 1 because of its much greater consumption rate.

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 40464, 40515, 41008, 41016, 41017, 41043, 41065, 41079, 41081, 41088, 41106, 41107, 41108, 41115, 41141, 41155, 41159

41018 Energy, economic growth, and human welfare. Schurr, S.H. (Resources for the Future, Inc., Washington, DC). pp 87-92 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Two propositions widely accepted until recent years but now subject to great controversy are basic to the connection that ties together energy, economic growth, and human welfare. They are simple propositions, the first of which asserts a direct and strong connection between economic growth and the growth in human welfare, and the second of which, in a parallel fashion, asserts a strong connection between energy growth and economic growth. The controversy surrounding these propositions is a mixture of ideology, facts, and the interpretations placed on the facts. The author examines economic growth and human welfare relationships, how economic growth affects energy consumption, and how energy supply affects economic growth and sums the considerations about appropriate policy approaches in the light of existing knowledge on these subjects.

41019 Energy and development in the Third World. Pachauri, R.K. (Coll. of India, Hyderabad). pp 569-575 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The paper enumerates and explores concepts in development related to energy in those Third World countries that are net importers of energy resources. Challenges of overall growth have to be met with solutions that remove existing imbalances and bring about socially efficient distribution and utilization of resources. Illustrative analysis based on observations about India is presented briefly to establish the importance of dovetailing energy policy with national development objectives.

41020 Energy dilemma in an urban desert: Phoenix. Cook, J. (Arizona State Univ., Tempe). pp 749-754 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Phoenix is the generic name for the conurbation of the Salt River Basin, one of 17 separate municipal governments that operate congruently, but independently. The dispursed, low-density settlement of metropolititan Phoenix is supported by a diffuse network of local centers. The phenomenal population growth of Phoenix continues. Land uses, climate, transportation, life styles, water resources, and growth patterns are discussed. Several patterns of residential land use that are both geographically adoptive and might suggest opportunity for energy sensitive future have emerged. These are described for Arcadia, The Lakes in Tempe, and Paradise Valley. For Phoenix, water is apparently available to accommodate existing and largely expanded potential needs of the future. It is deliverable without nuclear, or fossil-fuel conversions. Because water is provided via open canals that rely on gravity, even the pessimistic future for Phoenix would be one that is well-watered. That natural process generated and sustained the original high culture of the ancient inhabitants. That natural system with its water supply in a climate energized by dependable sunshine, offers the greatest potential for the continuity of human settlement and a substantial future at that place in the desert. (MCW)

41021 Superbia: an energy- and resource-conserving urban-design concept that meets human needs. Yu, O.S. (Electric Power Research Inst., Palo Alto, CA). pp 775-782 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

This paper presents an efficient, flexible, yet people-oriented urban design concept. In this concept, the central business district is enclosed in an integrated megastructure and surrounded by tightly-knit conventional suburban neighborhoods. For each neighborhood, service facilities such as stores, schools, and clinics, are also centrally located in enclosed structures. With this compact design, energy and material resources are conserved through integrated planning and the elimination of the need for personal autos. Furthermore, residents can simultaneously enjoy the excitement of an urban center and the tranquility of natural wilderness, all within walking distance. Illustrative design layouts are included.

41022 Urban systems: an overview and context setting. Schoen, R. pp 783-786 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The author reviews a chapter from Efficient Electricity Use—A Practical Handbook for an Energy-Constrained World, 1976 (EAPA 3:362) that he had written entitled: Energy Use in Cities. In that chapter he utilized colonial settlements established by Periclean Athens in Asia Minor around 5th Century B.C. and the Longhouse Cliff Dwellings of Mesa Verde which were constructed abut 1000 A.D. in southern Colorado as two special kinds of urban energy use examples. Both were communities that managed to capitalize on their local environments and, at the same time, limited their size in order to remain in balance with the available resource base of those environments. Excerpts from the chapter clearly show energy and resource conservation at the urban level. (MCW)

41023 Natural selection, human energy expenditure, and competition. Orians, G.H. (Univ. of Washington, Seattle). pp 847-852 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Concerns about energy use and energy conservation in the US are generally formulated in terms of perceived societal benefits and costs. Efficient use of energy in the thermodynamic sense, that is more useful work obtained from energy consumed, is regarded as beneficial. Attention is concentrated on energy wastage and the social costs of the overall low efficiencies of prevailing energy use patterns. Ecologists studying natural ecosystems from an energetic point of view have developed notions of efficiency of energy use and transfer that correspond closely, to those used in analysis of energy efficiency in human societies. An alternative approach to ecosystem processes, rather than concentrating on gross aspects of energy flow in natural or modified communities, focuses on the way in which energy harvesting by organisms has been molded by natural selection. This includes development of theories of the adaptive geometry of plants and their component parts, optimal foraging theory among animals, and theories of energy allocation to growth, reproduction, predator avoidance, and competition. These studies examine how natural selection molds such characteristics of organisms. The unit of accounting is inclusive fitness, the relative contribution of different genotypes or phenotypes (dependent on the form of the theory) to subsequent generations. These theories begin by making some assumptions about the action of natural selection on the traits in question from which predictions of morphology, behavior, or physiology are made. It is concluded that there is no reason to expect a close correlation between efficiency of energy use and fitness. The weak correlation are discussed. (MCW)

41024 International energy patterns. Rudman, R. (Electric Power Research Inst., Palo Alto, CA). pp 1037-1039 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The per capita consumption of primary energy resources is higher in the United States by a factor of 2 compared with other advanced countries such as Sweden, Germany, France where the per capita income does not differ appreciably from that of the United States. An attempt is made to gain some insight into this difference and examine its significance for US conservation policies. In economic systems, energy divided by GDP does not measure how efficient the US, or some other society is in its use of energy. In the generation of some GDP, it must be recognized that energy is only one factor of production. Capital, labor, technology, and materials are also factor inputs. And societies combine these in different ways. Much work must yet be done to compare energy consumption use. Many of the parameters are simply not quantifiable, e.g. differences in life styles. Serious international comparisons can serve to point out areas where it would be worthwhile to further investigate potentials for conservation, though. (MCW)

41025 How scientists can more effectively communicate with the general public. Frede, R.E. (Baylor College of Medicine, Houston, TX). pp 1049-1051 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

With respect to energy, the purpose of the communication program is to create or reinforce positive attitudes about energy development or production and conservation and to alter individual behavior in the direction of encouraging energy production and conservation. The problem of conflicting objectives within the scientific community must first be considered. Scientists must reach a consensus about what they want to communicate and why. Next, the audience to be reached must be considered. The scientists need to know who the people are and how they can be reached; their beliefs and their habits; their wants and goals; their level of knowledge about the subject; and the value system and cultural context in which they operate. Eleven essential ingredients of a communication plan

are listed. The author closes with some suggestions on communicating personally.

41026 How should governments & industry share in energy investments. English, J.M.; Smith, J.L. (Univ. of California, Los Angeles). pp 1053-1062 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

There are a number of economic conditions that make government participation in new energy investment an imperative. First, new investment in infrastructure is needed for providing the US with energy from new sources. Characteristically, investment in infrastructure is societal rather than private, although it is shown how the private sector does contribute to the building of infrastructure. Second, because new energy projects are complex and large-scale, the investment period is long term. Therefore, the paybacks appear unattractive to industry which is short-term-oriented. Finally, alternative cash-flow paths for a petroleum-based economy versus other-than-petroleum based economy are demonstrated to cross some time in the next century. The extra investment needed now to switch paths from the petroleum-based energy economy to a new path is shown to be the share of government investment. This is justified on the basis of a long-term discounted cash flow (DCF) analysis. While specific formulas for cost sharing are not spelled out, a fundamental philosophy for determining such formulas is proposed.

41027 US energy price and consumption changes in the mid-Seventies. Gelb, B.A.; Modica, L.C. (The Conference Board, New York, NY). pp 1063-1071 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Analyses of changes in energy prices and in energy use per unit of output in major consuming sectors indicate that, considering the steep real increases in the prices of energy sources, users (except in the industrial sector) have not reduced per-unit energy consumption as much as would be expected on the basis of published econometric price-elasticity estimates. This situation is reflected in the fact that there has been only a slight acceleration of the decrease in the energy-GNP ratio.

41028 Physical efficiency and economic efficiency as criteria for ranking energy systems. Yokell, M. (Solar Energy Research Inst., Golden, CO). pp 1083-1093 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Energy analysis and economic analysis are compared in detail as alternative methods for analyzing and ranking the efficiency of energy-conversion technologies. Energy analysis, despite the claims of its proponents, has no utility in this application. Economics, while suffering from severe defects on both fundamental and applied levels, is the appropriate conceptual tool for analyzing resource-allocation problems. At least on the applied level, the deficiencies in economics are, in principle, remediable.

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 41015, 41017, 41023, 41054, 41064, 41077, 41078, 41100, 41107, 41108, 41111, 41156, 41589

41029 Energy environments in ecosystems. Patten, B.C. (Univ. of Georgia, Athens). pp 853-857 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Energy control in natural ecosystems is achieved by virtue of position of components in energy-flow networks. These networks are made up of energy environments of the components. Every ecosystem component has two energy environments, an input and an output environment. Energy control relationships between ecosystem components are expressed by the ratio of importance of each given component in output vs input environments of other components. These ratios may be arranged in control matrices for ready display of energy control relationships between ecosystem components, both biotic and abiotic. Upper trophic level components may exert significant control over ecosystem energetics through their topological position in the flow network even though energy quantities involved may be relatively small. Relationally, the energy environment control measure is reflexive, asymmetric, and transitive or intransitive. The latter property may account for unusual energy-control relationships in real ecosystems and make understanding difficult to achieve.

41030 Energy conservation through interface ecosystems. Mitsch, W.J. (Inst. of Tech., Chicago, IL). pp 875-881 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Examples of ecosystems that are performing natural services for man are given. One example involves cypress domes in Florida where wastewater is being recycled. A second example is a floodplain cypress swamp in Southern Illinois where phosphorus uptake and flood control are seen as benefits. Both examples result in savings of energy compared with technological alternatives that perform the same functions. 20 references.

41031 Trend of recent revisions to sulfur oxide regulations and the impacts on fuel use. Crenshaw, J.D. (Environmental Protection Agency, Research Triangle Park, NC); Kuo, C.H. pp 1021-1027 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

To implement Federal ambient air standards for sulfur oxides, each state has devised a control plan for SO_2. Among other features, these plans include emission limiting regulations for SO_2 from fossil-fuel combustion units. In recent years, much attention has been focused on these regulations because of their impact on the supply of coal which can be burned. This paper briefly examines the types of SO_2 standards which have been promulgated in the various state plans and highlights how variations in features of these regulations can affect use. The paper disucsses the recent trend in SO_2 regulations can affect fuel use. The paper discussed the recent trend in SO_2 regulations - from emission limitations applicable over broad geographic areas to ones taylored to more localized air quality and growth situations. The paper concludes with some predictions about future trends toward more stringent SO_2 regulations in some parts of the US.

41032 Energy Facility Siting: a comprehensive program for Pennsylvania. Harrisburg, PA; Joint State Government Commission (1977). 76p. (NP—23782).

This report contains the findings of the Joint State Government Commission Task Force on Energy Facility Siting and recommended legislation. The scope of the siting problem; facility site approval and certification (Pennsylvania's fragmented process, one-stop siting procedure, proposed legislation); evaluation of local impacts of energy facilities (public utility property taxation, overall community impacts, proposed legislation); taxation and interstate transmission of electricity (existing Pennsylvania law, Federal Constitutional and Statutory provisions, proposed legislation); and proposed legislation (energy facility siting, gross receipts tax) are subjects covered. (MCW)

NATURAL RESOURCES

REFER ALSO TO CITATION(S) 41021, 41041, 41067, 41113

41033 (PB—287193) Transportation and development of Alaska natural resources. Commission study. Engelmen, P.; Tuck, B.; Kreitner, J.D.; Dooley, D.M. (Federal-State Land Use Planning Commission for Alaska, Anchorage (USA)). Mar 1978. 92p. NTIS PC A05/MF A01.

One of the central issues that has emerged in the analysis of the (d)(2) lands has been the relationship between access, transportation development, and land use. The importance of access to both Federal and non-Federal lands, particularly for major natural resource development, is clear. Two comprehensive questions delineate the principal concerns that have been addressed. Firstly, the question of future demand for transportation has been considered. This, in turn involves treating the potential for future resource development and the corollary issue of the role of transporation in determining the feasibility of resource development. The demands of settlement development and a growing population must also be considered. The second dimension of the overall analysis addresses the relationship of the (d)(2) lands and future transportation development. The paper is divided as follows: In Chapter 2, some general relationships between transportation and resource development are considered. In Chapter 3, renewable resources are analyzed. Chapter 4 focuses on hardrock minerals. Chapter 5 treats Alaska's energy resources. Chapter 6 discusses the issue of corridor designations on (d)(2) lands. In Chapter 7, general policy implications, conclusions, and recommendations are presented. These findings provide part of the basis for a forthcoming Commission document in which specific recommendations for a future corridor designation process are developed and presented.

41034 Energy from urban resource recovery systems. Conn, W.D. (Univ. of California, Los Angeles). pp 787-793 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

This paper briefly outlines waste-reduction and resource-recovery approaches to dealing with the ever-increasing municipal solid-waste problem, and discusses their potential energy implications. Some of the barriers to the implementation of these approaches are reviewed. Finally, anticipated impacts of the recently enacted Resource Conservation and Recovery Act of 1976 are presented. 17 references.

41035 Essays on food and energy. Catonsville, MD; Foundation for Self-Sufficiency Inc. (1977). 193p. (NP—23769). Foundation for Self-Sufficiency, 35 Maple Ave., Catonsville, MD.

Essays on resource conservation include: Limits of Non-renewable Resources; Energy and Energy Conservation: Public Schools; Mini-Shopping Guide: Windows; Tips from the Federal Energy Administration; and Reducing Household Water Use. Essays on solar energy include: Energy-Efficient Home—Solar Assisted: A Foundation Interview; Beer-Can Solar Collector; Home-Built Solar Collector; A Solar Hot-Air Retrofit; Black-Fluid Solar Collector; Suntrak Controller; and Solar Math. Essays on aquaculture include Fish Culture Basics; Backyard Beginning; Overwintering Tilapia in a Recirculating System; Community-Based Greenhouse/Fish Farm. Essays on gardening include: Try Community Gardening; Alternatives for Controlling Insect Pests; A Renewable Fertilizer; Companion Planting; Conserve: Preserve; Scrap Soup; and An Inexpensive Greenhouse. Essays on alternatives include The New and Improved Electric Beetle (Volkswagen body); Microbus/Methane and Propane. (MCW)

RESEARCH, DEVELOPMENT, DEMONSTRATION, AND COMMERCIALIZATION

REFER ALSO TO CITATION(S) 41076, 41078, 41090

41036 (FE—2468-29) **Escoe engineering program. Quarterly report, March 1—May 31, 1978.** Hill, R.F. (Engineering Societies Commission on Energy, Inc., Washington, DC (USA)). Aug 1978. Contract EF-77-C-01-2468. 27p. Dep. NTIS, PC A02/MF A01.

Objectives of this program are to conduct independent studies and to provide technical assistance to the DOE Fossil Energy Division of Program Control and Support. During this period, the program expanded with the addition of four technical tasks. One technical task was completed, and work continued on the other seven tasks which covered coal conversion, regional systems conversion to coal, examination of other research programs and systems, coal and oil mining, etc. (DLC)

41037 (FE—2468-32) **Basic engineering research scoping workshop, Washington, D.C., May 24-25, 1978. Final report on Tasks 013.** Hill, R.F. (Engineering Societies Commission on Energy, Inc., Washington, DC (USA)). Sep 1978. Contract EF-77-C-01-2468. 45p. Dep. NTIS, PC A03/MF A01.

The objectives of this report are to briefly describe the history leading up to DOE's interest in basic engineering research (BER); to introduce the reader to DOE's organization and its relationships with government laboratories, universities, and industry; and to present the results of the Scoping Workshop. Workshop participants discussed a wide diversity of opinions on a number of issues relevant to the planning of the BER program. The major issues were the degree of emphasis that should be placed on engineering problems of immediate value to specific DOE missions, the degree of emphasis that should be placed on the support of research work in engineering colleges, the degree to which the research program should be structured by DOE prior to requesting proposals, and the amount of emphasis that should be placed on basic engineering research rather than scientific research. Eight areas of highest priority to recommend for the initial BER program are: advanced industrial technology, electric power technology, fluid dynamics and thermal processes, geotechnical engineering, mechanics of solids, process end systems dynamics and control, reliability and risk analyses, and novel energy related engineering. (MCW)

41038 (LBL—8296) **Proceedings of the Hawaii inventors' conference.** (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1978. Contract W-7405-ENG-48. 76p. (CONF-780384—). Dep. NTIS, PC A05/MF A01.

From Hawaii inventors conference; Iliki, HI, USA (31 Mar 1978).

The First Hawaii Inventors' Conference was designed to satisfy specific objectives regarding the development, protection, and marketing of ideas and inventions. The program was designed to encourage inventors in Hawaii, stimulate more inventions to fruition, and add to the Hawaiian economy with knowledge gained from the papers presented. Papers presented and their authors are Reflections on the First Hawaii Inventors' Conference, Governor George R. Ariyoshi; Inventors' Guide to Creative Thinking, Norman C. Parrish; Two Ideas, Both Worth a Million Dollars, Robert G. Merrick; Department of Commerce/National Bureau of Standards Energy-Related Inventions Program, George P. Lewett; The National Technical Information Service, Peter F. Urbach; The Patent and Trademark Office Today, Lutrelle F. Parker; Technotec International Inventors' Registry, Walter H. Bruning; Appropriate Energy Technology, Joseph E. Machurek; The Process of Innovation for Financial Success, Phillip G. Larson; and Patents, Copyrights, and Trademarks, Murray K. Hatch. (MCW)

41039 (P—5843) **U.S.-Japanese cooperation in energy research and development.** Langer, P.F. (RAND Corp., Santa Monica, CA (USA)). Apr 1977. 20p. Rand Corp., Santa Monica, CA.

Japan and the United States differ markedly with regard to their energy resource endowment, the types of energy used in their economies, and their patterns of energy use. Any attempt to seek an effective coordination of U.S. and Japanese strategies in matters of energy research and development requires an understanding of the domestic and external context in which energy policies are formulated in the two countries, of the differences, contrasts, and similarities of their respective energy conditions, and of the policy objectives that flow from them. U.S. and Japanese technological research and development and perspectives on cooperation in energy research and development are discussed. A review of the past experiences and present condition of the U.S.-Japanese cooperation in matters of energy technology suggests three issues deserving priority for further study and cooperative action by the two partners in their joint activities. These are issues of energy conservation and efficient use of energy, uses and technology of coal, and establishment of a high-level energy forum. (MCW)

41040 (DOE-tr—163) **Answer of the Federal government on Pamphlet 8/2041: cooperation in the areas of research and technology with countries of the Third World.** 1 Aug 1978. Translation of Pamphlet 8/2074. 12p. Dep. NTIS, PC A02/MF A01.

This pamphlet is an answer of the Federal government to the minor inquiry of some representatives and political fractions of the SPD, FDP Pamphlet 8/2041 concerning the cooperation in the areas of research and technology with countries of the Third World. Thirteen questions on that subject are posed and answers are provided. One enclosure gives details on agreements of the Federal Republic of Germany concerning scientific-technological cooperation with developing countries. Another enclosure lists concluded or contemplated projects with developing countries. (MCW)

41041 Technical innovation: the answer to resource depletion. Starr, C. (Electric Power Research Inst., Palo Alto, CA). pp 71-86 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The world has always known resource limits - the predominant historical limits have been food and water. These limits have been overcome in two ways - geographic expansion and technical innovation. The possibility of geographic expansion has been largely exploited, but a wide range of technical solutions to resource pressures remain. Technical development represents the only truly unlimited resource. The concerns associated with projected resource short-falls have always been a result of a failure to recognize the important contribution of technical development. The global problems that we now face should not be viewed from a doomsday perspective, but rather as challenges and opportunities for stimulating technical innovation.

41042 Intermediate technology and energy-use management. Krishnayya, J.G. (Systems Research Inst., Pune, India). pp 583-585 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Intermediate or Appropriate Technology offers robust solutions to many energy and power problems. While technical research is welcome, the real problems lie in the economic, administrative, social, and community barriers to the survival, and growth or introduction of Appropriate Technology methods. Examples are given from SRI's experience.

41043 Role of the Federal government in energy research and development. Savitz, M.L. (Department of Energy, Washington,

DC). pp 975-980 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The Federal government contributes over half of the resources committed to R and D activities in this country, so it is important to debate the controversial role of the Federal government. The government's recent energy R, D, & D activities should be distinguished from the traditional role of government research programs. It funds consumer motivation, technology transfer, and other types of studies that the private sector could not be expected to pursue. The vast majority of the budget is for hardware-oriented projects, though. If these projects are to prove economically successful, they must be competitive both with technologies currently on the market and also with others being developed exclusively by the private sector. They must offer consumers a tangible advantage, as well as permit producers to gain a reasonable return on their investment. DOE has established a set of criteria for evaluating research proposals and deciding which of the approximaty 600 unsolicited proposals received each year should be funded. These concepts form the basis for government involvement in research and development that otherwise would not be available via the private sector. Discussions on the concepts (excludability, affordability, time preferences, uncertainty) are discussed. (MCW)

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 40379, 40389, 40464, 40467, 40820, 40846, 40860, 40861, 40862, 40863, 40864, 40865, 40866, 40867, 40868, 40869, 40870, 40997, 40998, 41116

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 40193, 41114, 41147, 41179

41044 Prospects of new electric energy storage devices. Fischer, W.; Gels, U.B.; Gross, F.; Liemert, K.; Rohr, F.J. (Brown, Boveri & Cie Ag, Heidelberg, Germany). pp 691-704 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

This paper discusses the results of a study comparing the technical and the estimated economical properties of some new storage systems with those of conventional peak power plants. The technical and economic properties of the following systems are considered: electrochemical storage (batteries and hydrogen storage devices); flywheels; steam storage/turbine facilities; compressed air storage plants; and gas turbines and pumped hydro for comparison. The following properties are of importance: utilization of abundant primary fuel; availability of construction materials; high efficiency; short construction time; siting flexibility; high safety, low pollution; and good economy. The analysis shows that electric peak power may be generated in the future not only by conventional systems as gas turbines and hydroelectric storage stations, but also by nonconventional systems as compressed air storage plants, batteries, and steam storage power stations. Flywheels and hydrogen storage facilities will not become competitive for short time applications (peak shaving). Battery storage systems have the particular advantage of being assembled of modules. A network with dispersed battery storage devices may be designed only for a mean power (base load) distribution and not for peak power distribution as in case of central peak power generation. 41 references. (MCW)

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 40214, 40758, 40791, 41068, 41073, 41170, 41175, 41176

41045 (CONF-790401—1) **Description of district heating: history and current status.** Karnitz, M.A.; Olszewski, M.; Anderson, T.D.; Rubin, A.M. (Oak Ridge National Lab., TN (USA); Department of Energy, Washington, DC (USA)). 1979. Contract W-7405-ENG-26. 17p. Dep. NTIS, PC A02/MF A01.

From District heating coal generation symposium; Minneapolis, MN, USA (2 Apr 1979).

District heating is defined as the distribution of thermal energy from a central source for residential and commercial space and hot-water heating. The central source can be either a boiler-only unit or a cogenation power plant that produces both electricity and thermal energy. The most-significant advantage of the cogeneration plant is its greater overall energy-utilization efficiency. In addition, district-heating systems can utilize coal or nuclear fuel as an energy source and thus substitute for more-limited resources such as oil and natural gas. This could lessen our requirement for imported oil, thereby reducing an already serious political as well as economic balance of payments problem. As far as the consumer is concerned, district heating has the potential to provide thermal energy at competitive rates with reasonably long-term price stability. The potential exists to significantly increase the implementation of district heating in the U.S. compared to the present market. This is especially true in urban areas with high population densities and large space heating demands. Many European countries already have large successful not-water district-heating systems. In order for the U.S. to follow suit, it is necessary to determine the economic feasibility of district heating. This requires consideration of many factors, such as climate, thermal loads, building types, energy sources, and environmental considerations among others. A recent analysis for the cities of Minneapolis and St. Paul clearly shows the economic viability of district heating for that area.

41046 Grid-connected electrical-thermal (cogeneration) energy system for the University of California, Davis. Boyen, J.L.; Martineau, C. Jr. (Energy Systems Planning, Inc., Palo Alto, CA). pp 285-298 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The energy system described represents the latest technology in on-site grid-connected systems for the power range used. The electrical portion of the system consists of a liquid-fuel-fired gas turbine driving a 3-MW alternator connected into the utility system. The gas turbine is supercharged to 12 inches wc. It is planned to operate the turbine-generator at full load continuously, thereby securing operation at the optimum fuel rate. Heat is recovered from the gas-turbine exhaust by a novel heat recovery boiler utilizing a controlled economizer. Steam is generated at 150 psig and is fed into the campus steam system for heating, air conditioning, and other uses. Steam rate is 20,300 lb/hr to a final stack temperature of 308° F. Additional heat is recovered from the turbine oil cooler, the alternator cooling air, and the boiler's continuous blowdown. The combination of electrical power generation and heat recovery from the above sources produces an overall plant efficiency of 83%.

41047 Potential of residential total energy systems. Kamat, D.M.; Drucker, E.E. (Syracuse Univ., NY). pp 611-619 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The feasibility of a small, packaged total energy system for residential-dwelling application is examined. It is believed that systems of in the 5-kW (electrical) size, utilizing mass-produced gas engines of the simple, reciprocating variety can be produced for sums in the order of 100 to 200 $/kW. Central-station electrical capacity costs at least 5 times that amount. Waste heat from the engine can be used for space and hot water heating, augmented by a heat pump. Such a system has been simulated on a digital computer, and run on an hour-by-hour basis in three cities: Boston, Dallas, and Minneapolis. Water storage and heat pipes are incorporated into the scheme. The system energy requirements and operating costs are compared to three conventional systems.

41048 Advanced and decentralized installations for combined production of heat and power in densely populated areas. Leijendeckers, P.H.H.; Engels, M.A.; Martens, H. pp 621-630 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

It is known that efficient energy consumption is of utmost importance now, both for the short- and medium-long term. In effectuating a more-efficient consumption of energy there are two important possibilities: a decrease in the ultimate use of energy, such as for heating, light, transportation; and an improvement in the output of the conversion of fuels in final functions (heat, electricity), and an improvement in their transport. The first possibility will take place through measures taken by the final consumers themselves. The second possibility requires technical, civil planning, and managerial measures for the energy supply of larger groups of consumers (the industry, urban housing areas). This will have consequences for the infrastructural provisions within communities and for selection of the technical systems that are to be employed in the future. This second category is the subject of this paper. Some new systems for a maximum conversion of fuels into final energy functions and components of these systems are discussed. In order to get the most-complete insight into the actual fuel consumption and savings with the combination of total energy, heat pump, and organic Rankine

cycle described, a computer simulation model was developed. The possibilities of such a system are offered. (MCW)

41049 Direct seawater/lakewater cooling systems. Hirshman, J. (Tracor Marine, Inc., Fort Lauderdale, FL). pp 795-807 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Those urban areas with a large cooling demand located near sources of natural cold water can, under favorable circumstances, cool buildings directly with this resource. Advances in off-shore pipeline technology and growing acceptance of district heating/cooling concepts make this a near-term option for energy conservation. Several studies to evaluate the technical and economic feasibility and the energy-savings potential of this concept were performed by Tracor Marine for ERDA. The first was a preliminary examination of four sites near the sea, followed by a site-specific study and a preliminary design for Miami Beach. A further phase of work examined the potential use of fresh water sources, such as lakes, reservoirs, rivers, and groundwater for this purpose. The US Navy Civil Engineering Laboratory independently examined this concept for possible use in Naval Facilities, and then had Tracor Marine perform a preliminary design, economic and energy analysis, and an environmental impact assessment for a demonstration project at a small USN facility.

41050 Status of district heating systems in the USA. Taylor, N.R. (International District Heating Association, Pittsburgh, PA). pp 809-812 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

District heating is the technology that provides heat energy to urban buildings from one or more sources external to those buildings. In 1877 one of the genious inventors of his time, Birdsill Holly, demonstrated in Lockport, New York, the feasibility of supplying steam heat to remote structures from a central boiler. In relatively few years similar systems were started in cities across the country, suppliers were attracted by new markets, and the technology improved rapidly. In addition to urban areas the method was soon adopted by institutions, university campuses, and other large groups of buildings. In more recent years the renewal of the core of many cities brought changes in district heating and the development of steam powered cooling systems became an important factor. Presently capital and fuel costs are curtailing district-heating growth in some sectors, however the potential of such systems for energy savings is commanding a renewed interest. The International District Heating Association maintains statistics on 40 distribution companies, on about 20 institutional type systems, and has done so for more than 50 years. This report is a summary and prognosis based on the most recent data.

41051 Saving waste heat. Ling, C.H. (AB Energikonsult, Stockholm, Sweden). pp 813-817 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Sweden is highly dependent on fossil fuel for its energy supply but has no deposits of fossil fuel other than alum slate and peat. About 78% of the total energy consumed in 1975 was imported. Due to their difficult situation, they are continuously looking for and developing new energy-saving concepts. The principles of some energy-saving concepts are discussed and references are made to actual installations in Sweden.

41052 Energy conservation potential of modular integrated utility systems in residential-commercial applications. Mixon, W.R. (Oak Ridge National Lab., TN). pp 827-833 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

HUD is conducting the Modular Integrated Utility System Program devoted to development and demonstration of the technical, economic, and institutional advantages of integrating the systems for providing all or several of the utility services for a community. Possible utility services include electric power, space heating and cooling, potable water, and liquid- and solid-waste treatment. A MIUS might be sized to accommodate several hundred or a few thousand multifamily dwelling units, nearby single-family housing, and associated commercial facilities. The concept utilizes a relativy samll, combined utility plant located on the development site and has the objective of providing utility services in a way that reduces the use of critical natural resources, protects the environment, and minimizes cost. Results related to energy conservation from analytical comparisons of MIUS with conventional utility systems, both serving a 720-unit garden apartment complex, are summarized. Based on commercially available technology, a MIUS model using internal combustion engines to drive ectric generators and waste heat from the engines for domestic heating and cooling was shown to be significantly more efficient in the use of input fuel energy over a wide range of climate. Energy savings with MIUS ranged from about 14% over the use of conventional heat pumps in San Diego to 50% over the use of electric resistance heating in Minneapolis. An overall average of comparisons with five conventional models in five climates amounted to a 30% savings of fuel energy with MIUS. The effects on energy use from using solid-waste incineration with heat recovery and thermal energy storage in MIUS are also discussed.

41053 Performance of operating total energy plants. Faddis, R.J.; McClure, C. (Argonne National Lab., IL). pp 835-846 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Three studies were undertaken in 1977 to evaluate three sites where electric and thermal needs were met by total electric energy systems. The three sites studied were: Southeast Missouri State University; Lawrence Park Heat, Light and Power Company, Bronxville, New York; and Western Mall, Sioux Falls, South Dakota. The study builds a data base of total and selective energy system operational information which lends itself to analysis for determining the energy conservation potential and economic viability of such systems. The sites studied were chosen from different geographic locations; institutional and regulatory environments; types and sizes of communities served; fuels used; and system configurations. This paper evaluates the conclusions drawn from the study. (MCW)

CONSERVATION

REFER ALSO TO CITATION(S) 40558, 40559, 41011, 41012, 41013, 41014, 41030, 41034, 41042, 41049, 41051, 41110, 41112, 41117, 41132, 41138, 41143, 41144, 41145, 41146, 41147, 41148, 41150, 41151, 41152, 41153, 41154, 41160, 41161, 41162, 41164, 41165, 41166, 41168, 41169, 41176, 41186, 41456, 41729

41054 (LBL—7882) Energy Conservation and the environment: conflict or complement. Schipper, L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; Kungliga Vetenskapsakademien, Stockholm (Sweden)). Sep 1978. Contract W-7405-ENG-48. 84p. (CONF-7809141—1; CONF-7810167—1). Dep. NTIS, PC A05/MF A01.

From Conference on impacts and risks of energy strategies; Stockholm, Sweden (Sep 1978).

The policy discussion following the Oil Embargo was clouded with fears of a return to a primitive existence based on drastically reduced energy inputs to society, or, on the other hand, an abandoning of environmental goals, allegedly a major barrier to development of new energy supplies. Often the energy use associated with environmental improvements was cited as a reason for expanding energy supplies, as if to say that a conflict existed between a clean environment and reductions in energy use. Or it was argued that a relaxation of environmental goals would lower the direct costs of harvesting and using energy and thereby alleviate the need for energy conservation. It has also been argued that the geopolitics of energy alone will force us to substitute riskier or "dirtier" energy sources for relatively clean oil and gas. Indeed, there is no question that the relationship among energy, the environment, and economic well-being is complicated. This essay sorts out many of the confusing aspects in order to show how goals relating to the efficient use of energy are aligned both with traditional economic goals and with modern environmental goals. To do this the author analyzes in depth the role of energy in the economy and, using examples, traces the origins of many of the misconceptions about that role--misconceptions that have inhibited a profound discussion of energy-related goals.

41055 World perspectives on energy management: the Tucson conference. Fazzolare, R.; Smith, C.B. pp 1-5 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The goals of the first International Conference on Energy Use Management were to concentrate on the utilization of energy, taking a holistic, interdisciplinary view and an international perspective. Five topic areas concentrated on major economic sectors where energy is used: industry, commerce, residences, transportation, and agriculture. They focused on the present status and the immediate short-term potential for improvements. The other six sessions were concerned with long-term perspectives, future policies and ap-

proaches that would lead to more efficient energy utilization: industrialization and development, science and engineering, architecture and land use planning, the natural environment, the role of government, and societal and economic aspects of efficient energy use. This overview presents some unifying conclusions and attitudes generated at the conference dealing particularly with population and energy demand increases; international policies; the special case of energy consumption in the US; interdisciplinary approaches to energy efficiency; planning (not forecasting) for the future; centralized planning - not the total answer; new and reborn technologies; need for emphasizing public education and the dissemination of information. (MCW)

41056 Summary of workshop sessions: industrial sector. Looney, Q. (Electric Power Research Inst., Palo Alto, CA). pp 7-11 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The five sessions on industrial energy management covered energy accounting and information systems; thermal processes; fuel and power managment; product design; and industry viewpoints. The three major conclusions of wide general interest from the five sessions are summarized. (1) A large number and wide variety of opportunities for improved energy management are available within the industrial sector. (2) The wide variety of energy conservation opportunities and the broad diversity of environments within which industrial plants operate suggest a need for decentralized decision making with a minimum of governmental intervention into the process. (3) A stable and predictable national energy policy is necessary to provide the proper environment for encouraging investment in energy-conserving devices and processes.

41057 Summary of sessions in the commercial sector. Taussig, R. (Mathematical Sciences Northwest, Inc., Bellevue, WA). pp 13-15 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Five sessions were encompassed by the Commercial Section in which 22 papers covered a wide range of problems of energy use. Sessions were entitled: HVAC Systems (6 papers); Building Envelope (3 papers); Building Systems - Simulation (3 papers); Building Systems - Operations (5 papers); and New Energy Systems and Components (5 papers). Robert Taussig concludes that there are numerous challenges to practitioners of energy use management in the commerical sector - that is, to give clearer warning to the government and to organizations affecting the revision of building design codes, construction standards, etc., to bring a stronger stimulus for the conservation of the scarce fuels in this sector. (MCW)

41058 Overview of the residential energy problem. Reagan, J.A. (Univ. of Arizona, Tucson). pp 17-21 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Four main topics were discussed on energy-use management in the residential sector, namely: Environmental Conditioning, Solar-Augmented Systems, Building Materials and Design, and Domestic Energy Management for a total of 29 papers. The author concludes that in the technical area, work must be continued to determine how energy-saving and management techniques related to environmental conditioning, building materials and design, appliances, and alternate energy sources can best be integrated into residences to achieve optimal energy efficiency in an overall system sense. Then, action is required on local, state, and Federal levels to establish energy policies that will be effective in encouraging large-scale implementation of measures which improve energy-use efficiency in residences. (MCW)

41059 Transportation and communication. Spencer, R.B. (Applied Nucleonics Co., Inc., Santa Moncia, CA). pp 23-27 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

This topic consists of 4 sessions: Vehicle Design and Concepts (4 papers); Urban Transport Modes and Systems (7 papers); Intercity Transport Operations (5 papers); and Telecommunications (8 papers). Brief summaries of the sessions are given and then Dr. Spencer concludes that the transportation and communication sector must be satisfied with a multiplicity of small energy-reduction opportunities. He believes that it is this small increment of energy savings in many areas that has caused apathy among the general public, but the value of small savings must be pointed out. (MCW)

41060 Agriculture. Taylor, G.B. (Applied Nucleonics Co., Inc., Santa Moncia, CA). pp 29-32 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The Agriculture and Food topic includes 5 sessions: Crop Production (5 papers); Crop Production - Irrigation (4 papers); Livestock Production (8 papers); Food Processing, Distribution, and Storage (5 papers); and Food Processing - Solar Applications (5 papers). The author summarizes the papers presented in these sessions and offers the following conclusions: (1) in order to assure that our descendants enjoy a high quality of life, population must be controlled; (2) control of population flows will reduce the problems associated with food production and distribution; (3) agriculture has already begun to utilize more-efficient methods in food production and processing; (4) use of forward and reverse osmosis in many processes will allow large reductions in energy utilized for evaporation as a means of concentration; and (5) man must now look more carefully at the encroachment of residential and industrial sectors on fertile agricultural land, since the acreage of good productive land is decreasing worldwide. (MCW)

41061 Industrialization and development. Kettani, A. (College of Engineering, Dhahram, Saudi Arabia). pp 33-34 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The topic, Industrialization and Development, dealt mainly with developing and lesser-developed Third World countries. Conclusions are summarized from the three sessions: Energy Supply and Needs (6 papers); Strategies and Approaches (9 papers); and Intermediate Technology (6 papers). Intermediate-technology sociologists should give thought to how asset-sharing could become more practical as a way of reducing capital requirements per capita, especially in LDC's. Developing countries need much better information exchange. Methods must be found to upgrade the quality of energy analysis and planning in LDC's, through training, supply of literature, and the subsidized attendance of research workers and analysts at relevant conferences such as ICEUM. (MCW)

41062 Science and Engineering Topic summary. Dyer, J.L. (California State Univ., Long Beach). pp 35-38 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The Science and Engineering Topic area is concerned with the technologies and equipment that will become available in the near future to energy consumers at all levels of society worldwide. Near future was taken to be 5 to 10 years. Because of high capital costs involved in some industries, the time span expanded to the early 21st century as required. The topic area was made up of five sessions: Thermodynamic Effectiveness (9 papers); Heat and Power (5 papers); System Analysis, Modeling and Simulation (11 papers); Advanced Efficient Appliances, Equipment and Devices (5 papers); and Advanced Energy Systems (7 papers). It is concluded that technologies either exist or are being developed that will provide for the better utilization of energy for the aspirations of mankind. These technologies will not be inexpensive. Economic conditions at all use levels will dictate which technologies will be developed. Gaining user acceptance of the advanced systems, particularly in the residential sector, is an emerging problem. The development of energy generating plants today, with their associated long-term paybacks, will determine our future fuel requirements. And it is important that strategies be developed that will bring advanced technologies to reality from the research and development area.

41063 Architecture and urban planning sessions: summation. Medlin, R.L. (Univ. of Arizona, Tucson). pp 39-42 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

A summary is presented of the 32 papers presented on the Topic, Architecture, Land Use, and Urban Planning. The 4 main subjects are: Materials and Structural Design (4 papers); Emerging Designs, Energy, Human Needs, and Environment (6 papers); Land Use and Urban Planning (10 papers); and Urban Systems (12 papers). Richard Medlin looks at the impacts global populations will have on energy use in the next 30 to 40 years. With the population estimated to double in that time span, a major consequence will be that because of the development of underdeveloped countries and the redistribution of wealth, somewhere between five and six billion (of a possible 8 billion) people will become high per capita resource consumers. He concludes that we must become internationally interdependent in terms of our resource utilization relationships.

41064 Energy and the natural environment. Smith, A.T. (Univ. of Miami, Coral Gables, FL). pp 43-47 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

A summary is given of the papers presented on the Topic: The Natural Environment. Session 1, Energy Flow in the Biosphere, contains 4 papers entitled: Natural Selection, Human Energy Expenditure, and Competition; Energy Environments in Ecosystems; Energy Analysis and Environmental Analysis in Transportation Planning; and Energy Conservation Through Interface Ecosystems. The second session, Energy Management in Nature, contains no published papers, but Dr. Smith cites complementary presentations by Bernd Heinrich and Gordon Orians. Each of these authors focuses on problems of optimal foraging. Session 3, Energy and Environment, contains 7 published papers. These are: Electric Generation: Issues of Scale and Political Authority; Energy Requirements for Pollution Control at Stationary Sources; The Effect of No/sub x/ Input on Tropospheric Ozone; Impacts of Environmental and Utility Siting Laws on Community Energy Systems; Trace Sulfur Compound Removal for Coal Gasification; Preliminary Assessment of the Energy Impact of Air and Water Pollution; and Mathematical Modeling of the Influence on Environment of Developing Countries in a World Economy Dominated by Industrial Nations. Dr. Smith concludes that efficiency of energy use is the highest goal to which man should be striving. One of the most bizzare problems that faces us - the changing climate on Earth and its resulting uncertainty - is the result of our gluttony and inefficiency in matters of energy conservation. (MCW)

41065 Societal and Economic Aspects. Gilliland, M.W. (Energy Policy Studies, Inc., El Paso, TX); Hall, T.A. pp 67-70 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Sessions in the topic area, Societal and Economic Aspects, included three papers covering various societal aspects of end-use management and two covering energy/economic aspects. The three on societal aspects were entitled International Energy Patterns, Public Communication, and Changing Lifestyles. The two on economic aspects were entitled Productivity and Employment and Energy Analysis. The authors summarize the papers presented on the topic. (MCW)

41066 ThermAtrace for energy management. Friedman, R.F. (Barnes Engineering Co., Stamford, CT). pp 133-139 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

One of the actions for energy conservation is thermal inspection. Present and future challenges in the energy-short environment dictate this requirement. The recent requirements for heat inspection prompted Barnes Engineering Company to design and produce a portable thermal-scanning infrared instrument which has been designated ThermAtrace. It operates over a wide spectral region and thermal anomalies are identified by a single line trace in the visual scene. Applications include surveys of industrial plants, home insulation, electrical inspections and in other areas of potential energy losses.

41067 Contribution of secondary materials to the conservation of energy. Henstock, M.E. (Univ. of Nottingham, England). pp 165-178 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The argument for materials and energy recovery is now firmly established for the general case. The net benefits in any particular instance must, however, depend on an assignment of value to factors such as energy, employment, avoided litter, extension of resource life, and reduced pollution from primary production of materials. Much scope exists for objective research into the many trade-off points involved in an evaluation of the relative merits of reuse, recycling, or disposal of manufactured goods. A quantitative assessment of the true importance, to the manufacturing industry, of the cost of raw materials has particular significance for the implementation of design changes calculated to make materials reclamation less energy-intensive. A systems approach to a given recovery program might consider factors such as the true energy requirement of volunteer collection of litter and the melting losses implicit in the recovery of materials from sources such as laminated packaging wastes, in order to assess the efficiency of current collection techniques and the validity of current packaging methods. 23 references.

41068 Energy savings in the Scandinavian pulp and paper industry. Nygaard, J.; Borg, A. (AB Energikonsult, Stockholm, Sweden). pp 179-184 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Scandinavian pulp and paper mills consume less external energy than do similar mills in the USA. In this paper a few examples are given of how to recover secondary heat and of the effect of this on the energy balance. Results from recent studies made by AB Energikonsult indicate that the energy produced from black liquor and bark can meet the total energy demand of the mill. Some differences between Scandinavian and American methods of calculating energy balances are described.

41069 Energy conservation in the steel industry of the United States. Corban, F.L. (Inland Steel Co., East Chicago, IL). pp 189-193 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The American Iron and Steel Institute made a detailed evaluation of the energy-efficient targets developed by the Federal Energy Administration and concluded that an improvement from the 1972 level of between 4.3 and 7.4% was the most likely result. The details of the AISI projection are given. Since that statement by AISI in December 1976, the steel industry has had more unsatisfactory financial results. Inadequate capital generation has reduced the industry's ability to expand with modern technology and, as a result, there is concern about achieving energy conservation goals. Whether a specific conservation goal is reached or not, it is apparent that the steel industry will strive to reduce energy costs to strengthen its financial position.

41070 Industry viewpoints: aluminum. Pritsky, W.W. (Aluminum Association, Washington, DC). pp 199-201 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

In May 1972, the Aluminum Association organized a broad program to deal with all of the basic problems existing in the industry, and the energy problem was prominent. So it was in a position to survey the industry in mid-1974 to determine the energy that might be saved by 1980 compared to the base of 1972, as mandated. The industry committed to saving about 10% energy on a per unit output basis by 1980 compared with the base year of 1972. Through the first half of 1977, the industry was able to report an energy efficiency improvement of 8.5%. Some production and operating methods, some housekeeping chores, and minor equipment modifications are identified where energy conservation has resulted. The greatest opportunity for energy conservation is in fabrication, and increased recycling of aluminum will produce additional energy savings. The industry believes the US must expand the energy supply base as well as conserve energy, but the Administration's program is not balanced as no stimulus for expanding supply is contained in it. (MCW)

41071 Energy management in the pulp and paper industries. Duke, J.M. (American Paper Inst., New York, NY). pp 203-205 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Firms that wish to remain competitive have always practiced energy conservation. In 1971, though, the paper industry launched a program of annual surveys of its energy use. Following the oil embargo, the industry set for itself a goal of reducing purchased energy use per unit of output by 10% between 1972 and 1980, provided environmental requirements did not interfere. With the passage of The Energy Policy and Conservation Act, the FEA originally set a 28% reduction in fossil fuel and purchased energy use per ton between 1972 and 1980 for the industry, but was then set at 20%. The industry has surpassed the 10% goal set for itself, but it is doubtful if the 20% goal by 1980 can be met. In 1976, of the total energy consumed by the paper industry, 45% of it was its own wood and wastes. (MCW)

41072 Optimizing wall and roof insulation in Bell System buildings to minimize energy consumption. McKay, J.R. (Bell Telephone Labs., Whippany, NJ). pp 215-224 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The Bell System currently owns or leases about 300 million square feet of floor space and is adding over 10 million square feet each year. Much of the new space will be smaller buildings - 10,000

square feet or less - housing electronic central offices. A unique feature of such buildings is the rather large heat output of the equipment, heat that normally ranges from 5 to 10 watts per square foot of floor space. With such buildings energy consumption for environmental control does not always decrease with increasing insulation. There is, typically, an optimum U factor at which energy consumption will be a minimum. This optimum U factor depends on many factors such as building size and configuration, heat load from equipment, lights, people, solar, etc., office temperature range desired, type and efficiency of the cooling and heating plant, and ventilation requirements. The optimum U factor can, of course, be determined by computing energy use as a function of U factor using one of several available computer design codes. An alternate method has been developed for estimating an optimum U factor, U/sub OPT/, which involves use of a thermal design parameter called T/sub OPT/. T/sub OPT/ is primarily a function of the location of interest, the indoor room temperature range desired, the cooling and heating plant efficiencies and fuel cost ratios. Tables of T/sub OPT/ may be constructed and are to be published by AT and T Co. AT and T Co. has requested ASHRAE to consider adoption of this method for determining U factors in buildings with high internal heat generation as an alternate to the method presented in ASHRAE 90-75, Section 4.

41073 Energy management at The Ohio State University. Fireovid, J.A. (Johnson Control, Inc., Columbus, OH); Birdsall, B.E. pp 267-273 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The Central Campus Energy Control Center (CCECC) explored how the computerized building automation system could be used most effectively at The Ohio State University. This study investigates OSU's past operating methods and their associated costs against revising them as a result of calculated savings achievable by effective utilization of the control center. It was discovered that large savings can be realized through changes in operating methods, especially with regards to electric utilities. The first section examines the operational procedures that are available to the power plant during the summer. Both peak shaving and load shedding were investigated for possible savings. The second section studies wintertime operation using the waste heat from generating electricity and supplying it to the campus through a low-temperature hot-water district-heating system.

41074 Use of secondary treated waste water for energy efficient crop production. Sanai, M.; Shayegan, J. (Arya Mehr Univ. of Tech., Tehran, Iran). pp 481-485 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Experiments are reported where secondary-treated waste water is used in place of ordinary irrigating water and chemical fertilizers. Progress in modern agriculture has indicated that photosynthetically efficient crop production requires regular irrigation and a balanced application of commercial fertilizers. Both of these requirements may be met simultaneously if secondary-treated sewage effluent is used in place of ordinary irrigating water. In this way, the nutritious minerals contained in the waste water is effectively utilized as they are biologically degraded by the micro-organisms and converted into biomass when absorbed through the root system. In the present project, a 5-hectare experimental farm of alfalfa and maize is irrigated with treated municipal waste water obtained from the city of Isfahan. The treatment plant is a conventional tricklingfilter facility and delivers an effluent enriched with nutritious minerals essential for plant growth. It is estimated that application of 1 cm of this waste water provides commercial fertilizers constituents equivalent to approximately 1.8 kg of nitrogen, (N), 2.1 kg of phosphate, (P_2O_5), and 2.2 kg of potash (K_2O), for each hectare of land irrigated with waste water. This would be nearly equal to applying 6.5 kg of a 7-8-10 commercial fertilizer to each hectare.

41075 Energy development decision-making: minimax versus expected value criterion. Weber, J.E.; Duckstein, L.; Davis, D.R. (Univ. of Arizona, Tucson). pp 681-689 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Energy decisions, which are usually made under various uncertainties concerning the state of nature, can be approached from either an expected-value or a minimax viewpoint. Several examples are used throughout the study to illustrate the differences between these two approaches. Formally, a decision problem includes a decision or action space (stream-temperature increase), a reward or loss space (monetary and social losses due to making a wrong decision), and probability distributions mapped on the reward space (probabilities) of ecological damage). The decision maker may choose such a probability distribution according to a Bayes (expected value) viewpoint or a minimax viewpoint; the minimax criterion may itself be expected value or absolute. The Bayes viewpoint is appropriate when (a) the decision maker can specify a prior distribution which is an accurate representation of the states of nature, and (b) a repetitive situation exists in which many large and small individual losses average out to the expected value without unacceptable consequences (many minor incidents). An expected minimax, which minimizes maximum expected loss, requires a repetitive situation and is based on the least favorable distribution of the state of nature; an absolute minimax, on the other hand, minimizes maximum possible loss. Minimax criteria are appropriate when a very serious loss, such as a major energy shortage, cannot be tolerated. Actual decisions appear to be based on a mix of the minimax and expected-value viewpoints; since these approaches require different types of data, it is important to identify which is to be used in a given problem. A more-careful consideration and identification of the approach used in decision making in energy management is important in evaluating the results and improving the process.

41076 Responsive environments: a new paradigm for an energy-efficient built environment. Higgs, F.S. (Louisiana State Univ., Baton Rouge, LA). pp 709-718 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

An artifically intelligent responsive environment can be considered to be a system capable of gratuitously reacting in a beneficial manner to the perceived (by the system) requirements and desires of the inhabitants found within its boundaries. Although virtually all of the built environment can be said to exhibit characteristics of intelligent responsiveness there exist no high-level examples of such a system today. A modest R and D program was initiated at the University of Texas during the spring of 1977 with the intention of increasing the understanding of how responsive environments could be implemented in the contemporary technological context. Energy efficiency was chosen as one of the organizing principles for an exercise in the development of a new paradigm of architecture. Several new concepts from this exercise are presented. Finally, an experiment was constructed and carried out which collected data for analysis by a context-free modeling methodology which appeared to be a good candidate for the role of the artificial intelligence within such a hypothetical system as might eventually be constructed.

41077 Identifying climatic design regions and assessing climatic impact on residential building design. Loftness, V.E. (A.I.A. Research Corp., Washington, DC). pp 733-744 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

This paper describes research to identify and assess the impact of climatic factors on human thermal comfort and the design of energy-conserving residential buildings. The analysis of base (temperature and humidity) climate data from 130 United States cities, in relation to a comfort zone based upon accepted temperature and humidity ranges, established predominant residential design conditions - from predominantly heating, to predominantly cooling, to predominantly comfortable. Assessing the potential influence of other climatic forces - radiation, wind, moisture addition, and diurnal temperature ranges - in bringing base climate conditions outside the comfort zone into the accepted temperature and humidity ranges, defined an expanded comfort zone that clarifies residential energy conserving design solutions in response to all climatic conditions. On the basis of the percent shift of conditions into the comfort zone when considering all climatic forces, residential climatic regions can be established that reflect common predominant design conditions and identify regionally available climatic forces for increasing natural comfort.

41078 Current research & development activities in the land use planning & energy-conservation field. Gillan, K.J. pp 755-760 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Preliminary research has suggested that savings up to 20% in community energy consumption could be achieved through a restructuring and spatial re-ordering of land-use activities. Community development patterns that are compatible with the utilization of mass transit systems, energy distribution systems (i.e. district heating and cooling), alternative energy sources (i.e. wind, solar, geothermal), and innovative building design concepts, offer significant promise for increasing efficiency of energy usage. Neither the energy savings nor the specific physical characteristics that are optimal for energy conservation have been extensively researched. This paper highlights the major research programs that Federal agencies have

supported or planned to initiate, summarize results, and suggest future areas for consideration. (MCW)

41079 Impacts of environmental and utility siting laws on community energy systems. Senew, M.J.; Shimamoto, G.T.; Seymour, D.A.; Santini, D.J. (Argonne National Lab., IL). pp 883-899 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

This study identifies specific Federal, state, and local laws likely to be encountered by ICES planners and developers. Knowing the relationship between ICES size and design and Federal, state, and local law provides a clear definition of regulatory obstacles. The influence of regulations on ICES vary. While some laws or ordinances dictate the siting of an ICES, others influence the system design, size, and economics. Larger ICES, for example, designed to meet environmental and siting restrictions, require the uneconomical use of stack gas scrubbing on the application of expensive fuels or uneconomical prime movers. If ICES are to be promoted as an energy conserving approach to utility generation, environmental and siting costs must be considered. Impediments caused by obsolete local zoning regulations and redundant environmental reviews can be minimized. Research can be directed toward providing an economical approach for environmentally acceptable fuel combustion and waste incineration.

41080 Energy conservation policy: an inventory & comparison. Hemphill, R.F. Jr. (Carnegie-Mellon Inst. of Research, Arlington, VA). pp 981-986 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

This paper attempts to describe and categorize energy-conservation policy as the field has developed over the last several years. Energy is usually defined as a measure of the capacity to do work and overcome resistance. Energy is never consumed directly, but only in the form of work accomplished, that is, the provision of heat, light, or movement. Energy, then, in the broadest terms, is translated into the goods and services that are the result of work. Energy conservation can thus be thought of in two clearly distinct ways. The first and possibly most common understanding is the sense of using less of the goods and services energy provides, and thus less energy. The second form of conservation, no less valid, is to make the provision of the goods and services more-efficient, i.e., to use less energy to come up with the same quantity of goods and services. Reasons that explain why the market responds less quickly and consistently to price signals than one would wish are discussed. Policies that prevent the market from functioning or that will not work - or why its workings should be overridden - are also discussed. (MCW)

41081 Some potentials for energy and peak power conservation in California. Rosenfeld, A.H. (Univ. of California, Berkeley). pp 987-1019 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Tables of conservation options are presented, ordered by maximum return on investment. If they could be implemented over 10 years, the following savings would result: natural gas and electric energy, each about 30% of 1975 consumption; peak power, nearly 50% of 1975 peak. The California consumer would then save annually about $1 billion of natural gas and another $1 billion of electric bills at 1975 prices. The cumulative first cost of the 10-year program is $5 billion, so the average annual return on investment is 40%. This $2 billion annual savings, if redirected from energy purchases to more typical and labor intensive purchases, would create about 60,000 jobs in California.

41082 Future international energy management: reconstructing sovereign rights and building international institutions. Lutz, R.E.; Francke, J.T. (McGeorge School of Law, Sacramento, CA). pp 1035-1036 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Internationally arranged energy management schemes must be designed to relieve the disproportionalte impact on the modernizing countries, the author says. The new functional institution required is an International Energy Institute capable of conducting thorough and impartial national resource assessments as the basis for multilateral project funding through such agencies as the International Bank for Reconstruction and Development. An additional function would be the sponsorship and evaluation of demonstration projects conducted by private industry in less developed countries. The unique threats of nuclear fission as a solution to world energy needs are briefly reviewed. A transition is envisaged to a world economy freed from reliance on oil as a fuel and energized instead by technology that releases the sun's energy cleanly from coal, captures it from the air or the oceans, or reproduces it in the heart of a thermonuclear furnace. Such a transition must be managed through international cooperation. The common principle is that certain natural resources that are at the same time unevenly distributed geographically, subject to irreversible depletion, and inherently irreplaceable for certain purposes of central public concern are to be conserved in general, restricted to their most appropriate uses and isolated to the utmost extent from political or economic abuses. Global energy resources are most appropriately manage with this principle for guidance. (MCW)

41083 Energy management in the Asian Productivity Organization member countries. Yoshida, K. (Univ. of Tokyo, Japan). pp 1041-1048 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Little information is now available on the situation of energy use concerning both the national and firm levels of Asian developing countries, although three billion people are consuming considerable amounts of energy. Recognizing the needs both for a large increase in supply and for conservation through more-efficient utilization, the Asian Productivity Organization conducted a survey and then organized a symposium to discuss measures for assisting member countries in the field of energy management. In this paper the current position of energy management is described and the major difficulties involved are identified.

41084 Energy conservation policy in the US: the emerging role of the Federal government. Hall, T.A. (Univ. of Oklahoma, Norman). pp 1095-1102 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

As domestic energy supplies and demands have become increasingly imbalanced and the nation has become more dependent on foreign oil, energy use has assumed a new significance as a policymaking issue. Public policy options to reduce energy demand generally include: financial incentives or penalties; mandatory conservation measures; the development of energy-conserving technologies; and the collection and dissemination of information to help consumers make efficiency and life-style decisions that could alter energy-wasteful habits. If public-policy innovations in this area are to be effective, more attention must be given to the linkage between policy alternatives and social and institutional factors that constrain implementation efforts. This paper surveys the advantages and disadvantages of the various options to achieve energy-conservation goals. This is accomplished by reviewing the policy tools available to government and summarizing recent Federal actions in the direction of conservation in the primary energy-consuming sectors. Several concluding observations are offered regarding future prospects and the government's emerging role in energy conservation. 20 references.

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 40507, 41103, 41158, 41159

41085 (CONF-780164—1) **Outlook for future energy supplies and costs.** Humphreys, K.K. (West Virginia Univ., Morgantown (USA)). 1978. 7p. West Virginia Univ., Coal Research Bureau, Morgantown, WV.

From 1978 cost engineering symposium; Miami Beach, FL, USA (20 Jan 1978).

Since the Arab oil embargo, the United States has become increasingly concerned about the stability of its long-range supplies of energy in all forms and has experienced sharp increases in energy costs. This paper presents a discussion of the actions being taken by the U.S. Government and industry to solve the "energy crisis" and attempts to project the future trends for energy supplies and costs in the United States.

41086 (DOE/EIA—0102/52) **Energy supply and demand in the midterm: 1985, 1990, and 1995. Analysis report.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Apr 1979. 223p. Dep. NTIS, PC A10/MF A01.

To account for the uncertainty inherent in projecting future energy production, consumption, prices, and associated variables, five basic projection series (A-E) are presented. These series constitute variations in assumptions influencing energy supply and demand curves. High energy demand curves are based on assumptions such as higher rates of economic activity and lower average efficiency of energy-consuming equipment and facilities (e.g., less insulation in buildings). The converse assumptions apply to low energy-demand

curves. High demand is assumed for Series A and B, and low demand is assumed for D and E. High energy-supply curves are based on assumptions such as lower energy-production costs, higher estimates of energy-resource availability, and a greater use of advanced energy-producing facilities (e.g., nuclear generating plants). The converse assumptions apply to low energy-supply curves. High supply is assumed for Series A and D, and low supply is assumed for Series B and E. Series C assumes medium supply and demand. Two additional scenarios, C-High and C-Low, evaluate the sensitivity of the Series C forecasts to variations in the projected world oil price. A computer model, called the Midterm Energy Forecasting System (MEFS), simulates the interactions of energy suppliers and consumers in the marketplace.

41087 (UCRL—15003) **Energy transition in California.** Christensen, M.N. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1979. Contract W-7405-ENG-48. 25p. Dep. NTIS, PC A02/MF A01.

Two general themes of the paper are that at the present time the most important decisions of long-range significance are being made not by suppliers of energy and their regulators but, rather, by end-users of energy and that the decisions of end-users will reduce aggregate demands for energy substantially below levels that are currently being forecast and will reduce even further demands for marketed forms of energy. The paper focuses on some major elements of consensus within current energy debates and the implications of that consensus for development of large-scale supply facilities, decisions by end-users of energy, and prospects for future demands for energy. The discussion focuses on events and circumstances in California, but uses some relevant information from other places. The paper argues that the common emphasis on disputed projections of depletion of oil and gas and disputes over siting of energy facilities obscures fundamental choices and developments that are already under way. Consensus on prospects of rising costs, environmental problems, and vulnerability to uncertainties is shaping the energy transition in ways that will constrain expansion of large-scale centralized supply and shift the focus of attention to improvements in efficiency of use of energy and to development of self-help sources. It is concluded that aggregate energy demands may well peak in theearly 1990's and that demands for marketed energy may well decline slowly thereafter.

41088 **Energy perspectives for developing nations.** Murthy, K.K. (National Inst. for Training in Industrial Engineering, Bombay, India). pp 93-96 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

An overview of the global energy position from the perspective of the Third World is presented here. In the context of accelerating depletion of hydrocarbon resources and their high prices, developing countries are finding it very difficult even to maintain the present extremely low levels of energy consumption. Since adequate supply of energy is crucial for economic development, their economic progress critically depends on the availability of energy resources. With the future prospects for cheaper energy being slim and the availability getting more difficult, low-energy-use structures for economic development have to be examined. By the adoption of such low-energy-use structures in the industrial and post-industrial nations, the large quantities of energy released will go a long way to supply the essential needs in the third world.

41089 **Sequential use of energy.** Grainger, L. (National Coal Board Ltd., London, England). pp 157-163 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

There is beginning to be an awareness of the need for energy conservation, in the sense of better thermal insulation and efficient cars, but there is less understanding of the far-more-important questions of efficiency in energy conversion, transport and storage, on the choice of energy form for final use, and on how these factors impact on primary energy-supply choices. At present, fossil fuels supply more than 90% of the world's energy demand. In 50 years, energy demand may have increased by a factor of at least two. If by then the non-fossil sources were intended to contribute one-third of the new total need, this would require an enormous effort in development and investment. This would still require an increase in fossil fuels of at least 40%. During this period, oil and gas will enter a declining output phase, so that if coal can double its output, this will almost certainly be needed. The author evaluates the available energy supplies and offers thoughts on energy modeling and concludes that better systems of thought on energy modeling need to be developed and put into practice by governments and by international agreement. More emphasis must be put on working back from end uses to primary inputs and on the efficiency of conversion, transport, and storage. The author's personal conclusions are listed. (MCW))

41090 **Distributed-Technologies Project: interim report of the California study.** Craig, P.P. (Univ. of California, Davis). pp 577-582 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The paper focuses on the development of distributed energy systems. These are related to soft technologies. Since many problems or issues can be evaluated only in comparison with alternative choices, the author includes a discussion of alternative hard systems. The criteria used in defining distributed systems, adapted from those suggested by Amory Lovins, are that the technologies be renewable, environmentally benign, local, subject to graceful failure, foolproof, flexible, comprehensible, and matched in energy quality. California is the nation's most populous state; energy supply and use differ from national averages. The fossil resource base of California is declining and there is no possibility of meeting a significant portion of the state's energy needs in the next century. Fossil fuels will be available at some cost, but it is assumed that these will be used to meet needs for petrochemical feedstocks, lubricants, and waxes and greases. California energy resource estimates for the year 2025 are made for solar energy, biomass (land and ocean), wind, geothermal, hydroelectric, ocean energy, and fossil fuels. End-use energy for the year 2025 is projected for agriculture; paper industry; transportation, commercial, and residential sectors. Pathways to the future described have not yet been explored; economic analysis has not been carried out; embodied energy in imports and exports from California has not been considered; sensitivity of analysis to major changes in energy supply and use technologies have not been undertaken; no vulnerability/resilience analysis has been carried out, but tentative observations are summarized. (MCW)

41091 **Methodology for evaluation and use of intermediate-term meteorologic forecasts in adjusting to energy crunches caused by extreme weather conditions.** Davis, D.R.; Krzysztofowicz, R. (Univ. of Arizona, Tucson). pp 653-661 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The effectiveness of using intermediate-term meteorologic forecasts to make advance adjustments in an area's mix of energy sources so as to mitigate the effects of sudden heavy demand for energy supplies due to unseasonably severe weather is made difficult by the uncertainty inherent in the weather forecast. A methodology is developed for comparing the effectiveness of the plans and standby procedures, such as curtailments, which are designed to be activated during weather severities, such as cold snaps. The methodology is based on a systems model, which is termed the weather severity forecasting-response model, and consists of a meteorologic network, a forecasting model, a decision model, and the action response. These are mathematically modeled in a manner which allows evaluation of a weather severity forecast-response system. Such evaluation depends on the accuracy of the forecasts and their timelessness as well as on the costs and losses involved in taking or not taking action. The actual value of a particular weather-severity-mitigation procedure is compared with the optimal value that could be obtained if the uncertainty in the forecast subsystem were handled in an optimal manner. The optimal value is in turn compared with the potential value which is based on perfect forecasts and response. Efficiencies of the overall weather severity forecast-response system can then be calculated as well as the efficiency of the forecasting subsystem and the response subsystem.

41092 **Effects of alternative technologies on the final energy-demand sector.** Reents, H.; Patzak, R.; Heckler, R. (Nuclear Research Center, Juelich, Germany). pp 663-680 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

If the basic, final, and primary energy demand of some selected technologies is compared, it is seen that by promotion of new technologies large effects on the energy demand are to be expected in the long range. Decision makers have to think about the real human needs and the wasted energy in all conversion stages. This work distinguishes between the original need energy demand, the system-dependent-need energy demand, the final energy demand, the secondary energy demand, and the primary energy demand. The energy saving alone cannot solve the future energy problems. There is also a necessity to substitute the highly critical final energy carriers by less critical energy carriers. There is extensive scope by promotion of new technologies to save energy and to substitute energy carriers. As a decision aid in these questions, a model system was developed in the Programme Group Systems Analysis and Technological Development of the Nuclear Research Center, Juelich. The structure of this model and its application possibilities are

covered in this paper. The author first reviews the energy demand, energy supply, and economic modules of the model and their connections. Then he describes in detail the final demand sector, distinguishing between the industrial, private household, commercial, transport, military, the non-energetic fuel consumption, and the petroleum sectors. (MCW)

41093 Value of the econometric approach to forecasting our energy future. Mayer, L.S. (Princeton Univ., NJ). pp 1073-1081 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

To many energy analysts and policymakers, econometric models of energy processes - models which are becoming prevalent in the energy literature - represent the ultimate in sophisticated scientific tools for the evaluation and generation of energy policy. For those analysts not familiar with the workings of the econometric models or the fundamentals of the econometric approach to modeling, the problem of assessing the importance of the econometric energy models as tools in analyzing and making policy is a difficult one. It may be particularly difficult to decide how much faith should be placed in the forecasts of our energy future generated by these tools. This paper provides the intelligent but uninitiated observer of our energy environment with a simple, straightforward evaluation of such models and of the methodology which underlies them.

41094 Ideology of the use of alternative sources of energy. Monasterio, F.O. pp 1103-1111 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The average American uses 8 tons of oil each year, 32 times more than the average person in underdeveloped countries. If energy consumption were allocated to each person equally, underdeveloped countries would triple their energy consumption, the socialist countries would remain almost constant, and the industrialized capitalist countries would have to reduce consumption enormously. So the energy crisis is a crisis of concentration, not shortage, even for the underdeveloped countries. The author uses Mexico as an example. With proven oil reserves of over 14,000 million barrels, and a production of 400 million barrels a year (that will be doubled in 1983), it would seem that Mexico has the capacity to satisfy the needs of oil for its own people. However, since the supplies are being used for export, to service the foreign debt, and consumed by a minority of Mexicans, the fact is that never was there so many millions of Mexicans without adequate supply of energy. It is noted that Americans have energy conservation as a central political issue, but at the same time adhere to exploitation of Mexican resources. The author believes though, that technological innovations that use nontraditional sources of energy are the only way to satisfy the needs of the rural masses in Mexico, 1977. Other subjects discussed by the author are Ideology of Innovations, Existence of Alternative Sources of Energy in Mexico, Parameters of Design, and System for Ecodevelopment of Agricultural Productivity. (MCW)

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 40315, 40514, 41019, 41031, 41079, 41080, 41082, 41084, 41111

41095 (ANL—78-62, pp 166-172) **Issues in coal utilization for power production in California.** Henwood, K. (California Energy Commission, Sacramento). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

California's energy policy is described. They are, of course, more worried about air pollution than some other states. This leads to a desire for careful site selection of fossil-fuel power plants and minimization of their environmental effects. A second program of interest is an effort to use resources both inside and outside the state to determine which technologies and issues will be important to California, again in planning for our future generation mix. To aid in this work the Commission recently approved two contracts for about $375,000 to look at problems of coal use particular to California. Two tasks receiving the most emphasis deal with (1) advanced coal utilization clean-up technologies especially applicable to our state's needs, and (2) health hazards and clean-up potential for currently unregulated emissions, such as the aforementioned heavy metals and trace hydrocarbons.

41096 (COO—4582-001) **Energy policy options for Illinois. Proceedings.** (Illinois Univ., Chicago (USA). Energy Resources Center). 1977. Contract EE-77-C-02-4582. 201p. (CONF-770973—). Dep. NTIS, PC A10/MF A01.

From 5. annual energy conference on energy policy options; Chicago, IL, USA (28 Sep 1977).

Twenty-six papers presented at the Fifth Annual Oil Illinois Energy Conference are categorized into five sections, namely: An overview of U.S. and Illinois Energy Policy; Energy Policy; Conservation—Solar—Biomass and Solid Wastes; Energy Policy; Petroleum and Natural Gas; Energy Policy; Coal and Electric Utilities; and Economic and Consumer Concerns. One paper, A Perspective on Long-Range Nuclear Energy Options, by William O. Harms has previously appeared in EAPA 4: 1364. (MCW)

41097 (DOE/TIC—10109) **National Energy Plan II.** (Department of Energy, Washington, DC (USA)). 1979. 355p. Dep. NTIS, PC A16/MF A01.

This volume contains the Administration's second National Energy Plan, as required by section 801 of the Department of Energy Organization Act (Public Law 95-91). A second volume will contain an assessment of the environmental trends associated with the energy futures reported here. Detailed appendices to the Plan will be published separately. The eight chapters and their subtitles are: Crisis and Uncertainty in the World Energy Future (The Immediate Crisis and the Continuing Problem, The Emergence of the Energy Problem, The Uncertainties of the World Energy Future, World Oil Prices, Consequences for the U.S.); The U.S. Energy Future: The Implications for Policy (The Near-, Mid-, and Long-Term, The Strategy in Perspective); Conservation (Historical Changes in Energy Use, Post-Embargo Changes - In Detail, Conservation Policies and Programs, The Role of Conservation); Oil and Gas (Oil, Natural Gas); Coal and Nuclear (Coal, Nuclear, Policy for Coal and Nuclear Power); Solar and Other Inexhaustible Energy Sources (Solar Energy, Geothermal, Fusion, A Strategy for Inexhaustible Resources); Making Decisions Promptly and Fairly (Managing Future Energy Crises: Emergency Planning, Managing the Current Shortfall: The Iranian Response Plan, Managing the Long-Term Energy Problem: The Institutional Framework, Fairness in Energy Policy, Public Participation in the Development of Energy Policy); and NEP-II and the Future (The Second National Energy Plan and the Nation's Energy Future, The Second National Energy Plan and the Economy, Employment and Energy Policy, The Second National Energy Plan and Individuals, The Second National Energy Plan and Capital Markets, and The Second National Energy Plan and the Environment). (MCW)

41098 (INIS-mf—4609) **Royal Order of 12 December 1975 setting up a National Energy Committee.** (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1978. 4p. (In French, Flemish). Dep. NTIS (US Sales Only), PC A02/MF A01.

The National Energy Committee was set up by Royal Order of 12 December 1975. Its duties are to advise on the general objectives of energy policy and its implementation. It supervises execution of the policy and makes recommendations on matters within its competence. The Committee is chaired by the Minister for Economic Affairs and Energy and is composed of representatives of the Government, trade unions, undertakings, consumers, gas and electricity committees, oil and coal industries and a delegate of the Planning Department. This Order repeals the Order of 17 July 1957 creating an Energy Advisory Council.

41099 (INIS-mf—4610) **Royal Order of 23 November 1977 amending the Royal order of 12 December 1975 setting up a National Energy Committee.** (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1978. 2p. (In French and Flemish). Dep. NTIS (US Sales Only), PC A02/MF A01.

Royal Order of 23 November 1977 modified the composition of the National Energy Committee. Members of delegations are appointed by the Minister for Economic Affairs for a 5-year period which is renewable. The Secretariat includes members recognised for their technical, economic or social competence in the energy field.

41100 Auto research and regulation. *Ed. Res. Rep. (Wash., D.C.);* 1: No. 8, 147-153(23 Feb 1979).

The American automobile industry is one of the nation's most regulated industries. A history of the antagonism between government regulatory agencies and the automobile industry is seen in safety regulations, emissions control, and fuel economy standards. The trend for the immediate future of automobile design will be small, lighter cars that are improved aerodynamically. Fundamentally different engines will not appear until the mid 1990's.

41101 Many sides to government involvement in energy-use management. Martin, L.H. pp 49-65 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The oral presentations made at this session on the role of government on energy use management are: Current US Federal/State Government Activity - An Overview; Research and Development - The US Approach to Energy Conservation Technologies and Strategies; Philosophy Behind the US Government's Approach to Energy-Use Management - An Analysis; Short Term/Long Term Approach - The Problem of Balance in Energy Policy; Local Versus Federal Implementation of Energy Policy; The Role of Large Metropolitan Regions in Energy-Use Management; Utilities' Contribution to the Energy-Use Efficiency Effort; The Contribution of Computer Models to Government Policy Making; Application of US Energy Policy to Low Income Groups and Small Businesses; Land Use/Transportation/Role of Cities; Roles of Pricing in Energy Use Management; The Energy Conservation/Environmental Protection Conflicts; Will Current Regulatory Strategies Have Any Significant Impact on Use; US Public Attitude/Its Relationship to Governmental Activity in the Energy Use Management Field; Impact of US Energy Policy on Other Parts of the World; Sweden Versus US - A Comparative Analysis of Government Energy Philosophies and Strategies; International Law Precepts - A Tool to Expedite Development of Uniform Worldwide Energy Use Management; Energy Crisis - Does it Exist. The author summarizes these presentations in this paper. The last topic discussed is Some Thoughts on the Future. (MCW)

41102 Chemical industry and the national energy plan. Brown, B.R. Jr. (E.I. du Pont de Nemours and Co., Wilmington, DE). pp 195-198 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The magnitude of the chemical industry; its dependence on energy for feedstocks, process fuel, and other uses; and the role it plays in this nation's balance of trade is examined. It clearly demonstrates our direct and substantial interest in the development of a rational and effective National Energy Policy. Being so energy-intensive, the chemical industry has two main concerns: a continued adequate supply of energy resources to meet our industry's growing need and fair and competitive pricing of such resources. The author reviews the measures contained in the energy plan. The chemical industry does not believe that the energy programs as submitted to Congress or as passed by the House address all the major issues. With regard to the key elements of the Administration's tax program, as passed by the House, the chemical industry applauds the exemption of feedstock and nonsubstitutable process uses from business user taxes. Observations are made on the Crude Oil Equalization Tax, the Business Use Tax, conservation, replacement of gas and oil with coal, synthetic natural gas, and balance of trade. The author then uses an example of replacing gas and oil with coal in existing or new facilities to examine the defects in the current mandates. The author says analysis of each major point of the National Energy Program and of the supporting House legislation will find similar defects to those he has described regarding coal conversions. A firm national policy is needed, but the Administration has contrived a revenue bill, not an energy bill, he concludes. (MCW)

41103 Energy strategy: the Philippine case. Madrid, N.R. (International Economics, New York, NY). pp 559-567 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The energy policy of the Philippines is discussed, and this paper is a critical review of the energy strategy. Both renewable and non-renewable energy forms play an important role in the energy scenario. Wood is used for cooking, tobacco curing, and forging. Solar energy and wind are used for drying clothes and crops; sailboats provide transportation; and hydroelectric power is used and is an important resource potential. Patterns of present use, present availability, and forecasts for 1985 and 2000 are discussed for hydroelectricity, geothermal-electric, nuclear power, oil, coal, nuclear energy, electricity, and non-conventional sources. The strategies and their financial aspects are discussed; conservation potentials are evaluated; and the application of appropriate technology for the islands is reviewed. (MCW)

41104 Energy policy at the grass roots: Los Angeles as a case study. Braly, M. (City Hall, Los Angeles, CA). pp 955-974 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Local governments, especially big ones, often have key decision-making authority and influence in energy issues. In the course of their deliberations on a number of unavoidable energy issues, Los Angeles city officials seem generally to have been guided by a set of five criteria for making these decisions in the general public interest. These criteria have emerged spontaneously from the dialogue, but they are made explicit here; and they are discussed in relation to the energy planning of the major southern California utilities. Questions are raised as to whether the energy future being planned for southern California by the utilities is the one that optimizes the five criteria for public welfare. A recommendation is made for better and more independent policy analysis at the local level of government, with assistance from higher levels of government. 25 references.

41105 Public opinion constraints on energy policymaking. Dettloff, J.A. (Univ. of Arizona, Tucson). pp 1029-1033 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The public approves of energy conservation as a means of dealing with the nation's energy problems by a substantial majority. However, care and leadership will have to be exercised by energy policymakers because approval of the principle does not always translate into approval of some policy measures. Positive economic incentives meet with considerable public approval, while reculatory measures such as rationing or negative economic measures such as additional gasoline taxes are strongly resisted.

41106 Proceedings of the 1978 rate symposium on problems of regulated industries. Foster, J.R.; Jones, S.B.; Wallace, R.L. (eds.). Columbia, MO; Extension Publications (1978). 562p. (CONF-780277—). $15.00.

From Rate symposium on problems of regulated industries; Kansas City, MO, USA (5 Feb 1978).

This volume contains the papers, discussions, and comments presented at the 1978 Rate Symposium on Problems of Regulated Industries. This was the fourth in a series of Symposia. The primary purpose of the series is to contribute to the development of practical solutions to the rate design problems. The introductory paper by M.W. Rockefeller provides background information on the status of Federal energy legislation at the time of the Symposium. This paper is followed by papers categorized into seven sections entitled: Effects of National Energy Policies on Rate Levels and Rate Structures; Natural Gas Prices: Supply and Demand; Problems and Progress in Electric Utility Rate Design; Costing and Pricing Gas Services; Costing and Pricing Communications Services; Costing and Pricing Rail Transportation Services; and National Standards for Public Utility Rate Design. (MCW)

FOSSIL FUELS

REFER ALSO TO CITATION(S) 40276, 41706

41107 Environmental guidelines for fossil energy site selection; considerations in land use and urban planning. Scott, R.L.; Metzler, J.F. (Pittsburgh Energy Research Center, PA). pp 769-774 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The guidelines of the Council on Environmental Quality state that environmental impact assessments must include an analysis of th probable impact of the proposed action on the overall environment. This would include impact on ecological systems, land use and development patterns, community and social organizations, and relevant quality of life indicators. At the Pittsburgh Energy Research Center, DOE, environmental guidelines for fossil-energy site selection are being developed. Fossil-fuel conversion plants have the potential to adversely affect the natural as well as the socio-political-economic environment. Each fossil-energy conversion process studied has its own specific resource requirements that must be integrated within a region so that it does not negatively affect that region's existing resource requirements and demands. Successful integration of current resource availability and demand with current process-feedstock requirements will satisfy existing and future energy needs of the region with minimum adverse impacts. This paper provides an overview of the potential impact of fossil-energy developments in land-use and urban planning.

COAL

REFER ALSO TO CITATION(S) 40095, 40104, 40185, 40193, 41010, 41089, 41095

41108 Case for anthracite. Heinz, J. *Environment;* **21**: No. 1, 2-4(Jan 1979).

The future of the anthracite coal industry and the economic viability of the Pennsylvania anthracite region will depend on whether the Environmental Protection Agency's (EPA) application of New Source Performance Standards (NSPS) consider economic

and energy factors as well as air quality. The required use of scrubbers will make anthracite non-competitive with other coals in spite of its high heat value and low sulfur content. The case for continued mining of anthracite in conjunction with a total reclamation of previous mining damage is based on economic and environmental effects. It is argued that a flexible EPA policy which sets special standards for anthracite coal will maximize environmental protection by improving the region's economy.

41109 Role of thermodynamic effectiveness in evaluating coal conversion R, D, & D. Ruppel, T.C.; Peters, W.C.; Schwartz, D.L. (Pittsburgh Energy Research Center, PA). pp 587-599 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Problems with conventional (first law) thermodynamic analysis in evaluating and developing coal-conversion R, D, & D priorities are discussed and compared with second law availability studies of gasification reactors. The gasification process is characterized with respect to the relative quantity and quality of the input/output streams. The analysis forms the basis for a discussion of the potential practical value of effectiveness as a parameter for optimizing coal-conversion efficiency. A thermodynamic comparison of four conceptual or operating commercial gasifiers and one pilot-plant size gasifier is presented. The first and second law (effectiveness) efficiencies are tabulated. The data on gasifier No. 1 is taken from the material and energy balance design data for a pilot plant. Gasifier Nos. 2 and 3 are conceptual designs for commercial plants and Nos. 4 and 5 are operating commercial plants.

41110 Energy conservation in coal conversion. Energy conservation potential in heat recovery techniques: a case study. Purcupile, J.C.; Stas, J.D. (Carnegie-Mellon Univ., Pittsburgh, PA). pp 601-610 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

A second-law efficiency analysis was performed on all heat exchanges in the commercial synthane plant designed for western coal having a capacity of 250 mm/cubic feet per day of synthetic natural gas. This analysis was performed to pinpoint areas where heat was not being used to its fullest potential and consequently identified areas for possible plant modifications from an energy utilization viewpoint. While a second-law analysis is a valuable tool to identify where the work potential of heat is not being fully realized, it should be recognized that it is only a tool or the first step in the design process. In this study, the authors looked at replacing certain heat exchangers with organic Rankine cycles (ORCs). In each case, they determined the cost of generating power; then, from this tabulation of capital investment for power generation, feasibility of replacement on a unit-by-unit basis was determined. Results show that over 105,000,000 kWh of electricity can be generated annually by utilizing ORCs at an installed cost of $310/kW. The conclusions dictate that ORCs should be incorporated into commercial synthane designs.

41111 Preliminary assessment of the energy impact of air and water pollution controls on coal conversion. Peters, W.C; Lorenzi, L. (Pittsburgh Energy Research Center, PA). pp 915-930 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The enactment and enforcement of air- and water-pollution-control regulations on the proposed coal-conversion industry may have a substantial impact on the energy consumption requirements. Environment-protection and energy-consumption optimization trade-offs will probably have to be made. The DOE Pittsburgh Energy Research Center, made a preliminary assessment of the energy requirements of environmental-control technologies as part of a much broader study involving environmental-impact and control-technology assessment activities in coal-conversion-process technologies. Energy penalties associated with specific pollution-control equipment are presented. The energy effects of coal cleaning to reduce the sulfur load on the control equipment are discussed. The energy-consumption data are extrapolated to a commercial coal-conversion industry and the projected energy impacts of the proposed environmental standards are described in terms of the quantity of coal needed for compliance.

PETROLEUM

REFER ALSO TO CITATION(S) 40304, 40305

NATURAL GAS

REFER ALSO TO CITATION(S) 40321, 40329, 40330

41112 Efficient energy use through natural gas load-management techniques. Macriss, R.A. (Inst. of Gas Tech., Chicago, IL). pp 141-145 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Load management can be an effective means to increase energy-use efficiency. A number of customer and utility-controlled load-management techniques are presently being developed, field-tested, and, in some cases, used by electric utilities. Such load-management techniques have not found significant application in the gas-utility industry because of the unique technical differences between the production and distribution of electric power and gas. However, several different methods for load management are conceivable for the gas-utility industry. Among these, flow restriction of certain residential space-heating equipment and gas-heating value control by the addition of small amounts of hydrogen, are discussed in this paper. The potential technological, economic, and institutional constraints to implement such techniques are also presented.

41113 Conservation of associated gas in OAPEC member countries. Jamali, U.F. pp 537-547 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Globally, about 40% of gas reserves are associated with oil, 60% are unassociated. The management and conservation of associated gas is frustrating because its production is not decided upon independently. Unassociated gas is produced in response to a specific demand. The factor that decides the quantity of associated gas production is the demand for the type of oil with which it is associated. The advancement made in the liquefaction of gas in the 1960s provided an impetus to make associated gas an international commodity. The interaction of the price and oil and gas is discussed. Legislation now affecting conservation of gas in OAPEC member countries is reviewed. The projects that are utilizing OAPEC associated gas and thus reducing the proportion flared fall into four categories. These measures are discussed for the United Arab Amirates, Saudi Arabia, Egypt, Bahrain, Libya, Algeria, Qatar, and Kuwait. (MCW)

HYDROGEN AND SYNTHETIC FUELS

REFER ALSO TO CITATION(S) 41120

41114 (PNL—2768) Assessment of synfuel transportation to year 2000. Wakamiya, W.; Sebelien, K.B.; Parkhurst, M.A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Mar 1979. Contract EY-76-C-06-1830. 113p. Dep. NTIS, PC A06/MF A01.

This report identifies and discusses potential problems in the transportation of synthetic fuels (synfuels) which if allowed to persist unresolved will hamper the development of these energy materials between now and the year 2000. The emergence of transportation-related problems in shale oil and coal synfuel development will be highly dependent upon their chemical similitude with analagous fossil fuels. Hence, definitive resolution of the question of whether new transportation problems exist is dependent upon clear characterization of the synfuels chemical composition. Hydrogen and methanol represent unique cases since these materials are already in commercial production. The major transportation problem identified with fuel economics based on these materials is related to bulk use. To date, shipment volumes have been relatively small and, in the case of hydrogen, can be accommodated with costly, more specialized packaging. Scale-up for major energy use may introduce a new set of transportation problems.

ELECTRIC POWER

REFER ALSO TO CITATION(S) 41141, 41143

ELECTRIC POWER GENERATION

REFER ALSO TO CITATION(S) 40504, 40509, 41046, 41081

CONSUMPTION AND UTILIZATION

REFER ALSO TO CITATION(S) 41016, 41022, 41023, 41027, 41056, 41057, 41058, 41059, 41060, 41061, 41062, 41063, 41064, 41065, 41072, 41087, 41101, 41160, 41161, 41169

41115 Developing test methods for measuring energy consumption of home appliances which represent consumer usage. Blanck, W.H. Jr. (Association of Home Appliance Manufacturers, Chicago, IL). pp 325-334 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

With the advent of the Federal energy program and accompanying energy labeling, it became evident to the appliance industry that consumer usage information was required. The author of this paper addresses his remarks primarily to the energy-consumption testing methods of refrigerators-freezers, ranges, and ovens. The refrigerator-freezer industry has developed an efficiency-related measurement referred to as the Energy Factor; the calculation method is described. The key oven test parameters included oven temperature, time to heat load (or load endpoint temperature), initial temperature of the load, and mass and specific heat of the load. Some oven efficiencies for various food items are listed. Key parameters required for the microwave efficiency measurements included the load shape, load size, composition of the load, starting temperatures of the load, and the ending temperature. (MCW)

UNCONVENTIONAL SOURCES AND POWER GENERATION

REFER ALSO TO CITATION(S) 41094

41116 (EPRI-ER—979) EPRI New Energy Resources Department strategy paper. Final report; January 1979. Lotker, M. (Booz, Allen and Hamilton, Inc., Bethesda, MD (USA)). 1979. 114p. Dep. NTIS, PC A06/MF A01.

The heightened interest by all sectors of the energy marketplace in the renewable or virtually inexhaustible energy sources has led to the formation of the New Energy Resources (NER) Department. This Department serves as a focus for electric utility industry efforts in the fusion, solar, and geothermal areas. In examining the performance and plans of the NER Department, it is appropriate to question the national need for these technologies and the appropriate role of EPRI and the electric utility industry in their development; and then, assuming an EPRI role is indeed merited, to develop a specific strategy or set of strategy options for pursuit of each technology. Strategy development at EPRI requires significant effort to: (1) determine the appropriate EPRI and utility role at each stage of development; (2) illuminate the tradeoffs involved in connection with various levels of NER Department funding; and (3) provide for utility industry input into the program formulation and prioritization process. This report details the rationale for national and utility industry involvement in NER technology and describes the procedures currently being used to formulate EPRI programs in each of the NER technologies.

SOLAR

REFER ALSO TO CITATION(S) 40505, 40507, 40509, 40510, 40512, 40513, 40514, 40515, 40555, 40558, 40559, 40560, 40561, 40562, 40563, 40564, 41013, 41144

41117 Residential solar-augmented systems: an overview. Kreith, F. (Solar Energy Research Inst., Golden, CO). pp 377-383 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The author presents some general observations and recommendations that may be useful for an assessment of where residential solar-augmented systems stand today and what the key problems are that must be overcome if solar energy is to be used in the comfort industry on a large scale. Two applications commercially available are providing hot water and heating of swimming pools. A large number of manufacturers in the US supply complete solar hot-water systems. More than 3,000 buildings in the US are using solar-heating systems. In addition to active solar heating, numerous studies have investigated the potential of passive solar systems, such as a solar-heated greenhouse attached to a dwelling. Solar energy can supply a portion of residential heat requirements, but the author says that at the present time it is usually more economical to reduce the heating requirements by better insulation, storm windows, and practicing other energy-saving features. One type of solar-augmented system that has not yet been widely used is the solar-assisted heat pump; the design and optimization of such systems require a degree of sophistication not generally available in the commercial building industry. (MCW)

41118 Project SAGE update: a possible utility role in the commercialization of solar energy. Hirshberg, A.S. (Booz Allen and Hamilton Inc., Bethesda, MD). pp 385-388 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Project SAGE is a 5-year program to examine the feasibility of the commercial use of solar-water-heating systems on apartment buildings. Part of the third phase of the project examined several roles a utility could play that would help speed the use of solar energy. Utility involvement in solar is a subject of growing national debate. This paper summarizes some of the results of SAGE and discusses some of the positive features of utility involvement in solar energy.

41119 Models and methods for the analysis and optimization of solar energy systems. Bruno, R.; Kersten, R. (Philips Research Lab., Aachen, Germany). pp 643-651 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Several methods of calculating the dynamic behavior of solar energy systems were investigated. These methods can be classified into three categories: the finite-element approach, the component-black-box approach, and simplified methods. In each case special attention was concentrated on reduction of computer time and maintenance of calculation accuracy. It is shown that the component-black-box approach can be solved by either an exact integration over an elementary time period or by cyclic convergence (modular method). The exact solution indicates that the number of equations to be solved may be reduced by a lumped-circuit separation approach. In either of the first two categories, hour-by-hour weather data are required for calculations. The simplified method considered uses the lumped-circuit equations with an analytic form for both weather and load data. It is shown that, in going from the finite-element approach to the simplified-method computation, time can be reduced by over three orders of magnitude and year-round accuracy is maintained to within 1%.

GEOTHERMAL

REFER ALSO TO CITATION(S) 40580, 40581, 40600, 40655, 40659, 40661, 40665, 40673

OTHER

REFER ALSO TO CITATION(S) 40497, 40499, 40543, 40776, 40791, 41034, 41175, 41456

41120 Economics of the bioconversion of livestock wastes. Thornton, T. (USDA, ERS, Washington, DC). pp 487-490 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Livestock manures have been seriously advocated for bioconversion to energy. The process of anaerobic digestion can convert manure to methane, fertilizer, and animal feed. Anaerobic digestion is technically feasible. It is economically feasible only in selected instances, usually associated with very large cattle feedlots. Economic and structural considerations prohibit widespread adoption of anaerobic digestion in American agriculture.

ENERGY CONVERSION

MHD GENERATORS

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 41300, 41323, 41324, 41325, 41326

41121 (AD-A—060156) High energy MHD fuels development program. Final report, March 1975—December 1977. Eckels, R.E. (Systems Research Labs., Inc., Dayton, OH (USA). Aerosystems Research Div.). Apr 1978. Contract F33615-75-C-2043. 374p. NTIS PC A16/MF A01.

An analytical study compared the electrical conductivity and velocity squared product for several MHD liquid or liquified fuels. Aluminum additive to liquid hydrocarbon was found to be attractive for high power density MHD. A number of MHD power tests showed that developed emulsified slurry fuels were engineeringly feasible. Various emulsification processes are described. (Author)

41122 (ANL—78-62, pp 392-415) **Plasma duct for instrumentation, materials, and process analysis.** Taboas, A.L.; Singh, R.N.; Johnson, T.R. (Argonne National Lab., IL). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

A versatile, low cost, MHD Engineering Test Unit (METU) has been constructed and operated at Argonne National Laboratory (ANL) to experimentally verify analytical models of transport processes pertaining to open-cycle coal-fired magnetohydrodynamic (MHD) power generation, and to assist in the design of other facilities by identification and evaluation of suitable instrumentation and materials. The METU consists of a commercial flame sprayer (plasma torch), and engineering test station (ETS), a materials test station (MTS), and support equipment. The intent of this paper is to provide a summary description of the METU, the results of preliminary experiments, and to announce the availability of the station for independent evaluation of components.

41123 (CONF-781009—, pp 573-601) **Third joint test of US electrode systems in the USSR U-02 facility.** Sadler, J.W. (Westinghouse Advanced Energy Systems Division, Pittsburgh, PA); Rossing, B.R.; Bates, J.L.; Marchant, D.D.; Negas, T.; Hosler, W.R.; Schneider, S.J. 1978.

From 4. US-USSR colloquium on MHD electric power generation; Washington, DC, USA (5 Oct 1978).

The main objective of the test was to evaluate the behavior and performance of the electrode system and to establish the characteristics of various materials of construction (particularly electrodes, insulators, current lead-out materials and attachments) during long term operation under clean firing MHD conditions. The test was carried out in the U-02 following a predetermined work plan and was monitored by a joint working group consisting of US and USSR specialists. The duration of the test was 132 hours, 100 of which were under full MHD conditions. A synopsis of the experiment is presented including significant details of electrode system design and construction, a description of materials and a preliminary evaluation of materials performance. (WHK)

41124 (CONF-781009—, pp 689-711) **Electrochemical corrosion of ceramic materials in MHD slag/seed.** Cadoff, L.H. (Westinghouse R and D Center, Pittsburgh, PA); Rossing, B.R.; Marchant, D.D.; Bates, J.L. 1978.

From 4. US-USSR colloquium on MHD electric power generation; Washington, DC, USA (5 Oct 1978).

The understanding of ectrochemical reactions is critically important to the selection of electrode materials for magnetohydrodynamic (MHD) channels. Electrochemical reactions will generally result in enhanced corrosion of electrodes in both slagging and nonslagging environments. Recent electrochemical laboratory tests on potential ceramic electrode materials ($3MgAl_2O_4.1Fe_3O_4$, $LaCrO_3$, $MgCr_2O_4$, $9HfO_2.1T_4O_7$, $MoSi_2$) are reviewed. These electrodes were tested in molten K_2SO_4, and eastern and western US coal slags at various temperatures and current densities. The chemistry, mechanisms, reaction kinetics, and the implications of electrode/slag-seed reactions to MHD channel performance are evaluated and discussed in detail.

DUCT ENGINEERING AND FLUID DYNAMICS

41125 **Hall effect in an induction discharge.** Zhilinskii, A.P.; Kuteev, B.V.; Smirnov, A.S.; Tukhvatulin, R.S. (M. I. Kalinin Leningrad Polytechnical Institute). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **23**: No. 10, 1166-1167(Oct 1978).

In relation to the development of an efficient closed-loop MHD generator, the Hall effect in a pulsed induction discharge is studied. it is shown that high values of the Hall parameter can be obtained in direct-flow electrodeless discharges as well as in rf discharges.

41126 **Combustion-products turbulence in the channel of an MHD generator.** Bystryi, A.I.; Ganefel'd, R.V.; Red'kin, V.B. (Institute of Electrodynamics, Academy of Sciences of the Ukrainian SSR, Kiev). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **23**: No. 10, 1182-1185(Oct 1978).

The turbulence characteristics of the combustion-products plasma in the channel of an MHD generator are studied experimentally. The study is devoted primarily to the characteristic dimensions, levels, correlation functions, and the spectral characteristics of the turbulence. Magnetic and electric fields modify the turbulence structure.

EHD GENERATORS

41127 (COO—1248-55) **Aerodynamic particle size measurement by laser—Doppler velocimetry. Publication number 343.** Wilson, J.C. (Minnesota Univ., Minneapolis (USA). Particle Technology Lab.). Dec 1977. Contract EY-76-S-02-1248. 230p. Dep. NTIS, PC A11/MF A01.

Thesis.

A method of measuring the aerodynamic diameter of aerosol particles was investigated. The method consists of accelerating particles in a coverging nozzle and measuring their velocities near the exit of th nozzle with a laser—Doppler velocimeter. The experimental studies utilized a test nozzle with a converging angle of approximately 15° and an exit diameter of about .1 cm. The pressure drop across the nozzle was varied from 2.54 to 276 cm of H_2O, and particle velocity was observed to vary from approximately 0.5 to 1.0 times the gas velocity at the exit of the nozzle. A theoretical analysis utilized boundary layer theory to predict the velocity of the gas in the nozzle, and then the equations of particle motion were integrated to give the theoretical particle velocities. These values agreed with the experimental values to within a few percent. The effects of nozzle geometry, flow rate, particle density, and particle size were studied using the results of calculations made with dimensionless equations. The velocity of a particle in a given nozzle and flow depends upon the aerodynamic diameter of the particle and the particle density. The geometry and flow can be chosen to minimize the effect of particle density. Assuming that the density of particles in the atmosphere ranges from 1 g/cm^3 to 3 g/cm^3, the aerodynamic diameter of particles can be measured with an uncertainty of +- 10% in the size range from .5 μm to 10 μm.

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 40482

THERMIONIC CONVERTERS

DESIGN AND DEVELOPMENT

41128 **Theory of the pulsed operation of a thermionic converter. II. Ionization stage.** Zherebtsov, V.A.; Talanova, V.D. *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **23**: No. 10, 1201-1206(Oct 1978).

The ionization stage in the pulsed operation of a thermionic converter is studied for the case in which a negative voltage pulse is applied to the anode. If the working medium consists of a single component, the ions are formed in a thin sheath near the anode, seriously reducing the efficiency with which the ions are used in the decay stage. Furthermore, when the diode is filled with heavy inert gases, the energy expended on forming an ion is high (~60 eV). In a two-component medium the ionization region can be expanded and the energy expended on the formation of an ion can be reduced. In this case the ions are used efficiently and the voltage drop associated with the energy expended in plasma formation can be kept small ($\sim 10^{-2}$ V).

PERFORMANCE AND TESTING

41129 **Gas discharges in planar low-pressure thermionic diodes. I. Space-charge regime.** Bromberg, L.; Smullin, L.D. (Plasma Fusion Center and Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *J. Appl. Phys.;* **50**: No. 4, 2630-2633(Apr 1979).

Current flow in a gas-filled planar thermionic diode is studied for the case when pd is small, i.e., the diode spacing is small compared with the collision mean free path. The fast primary electrons ionize the gas and the positive space charge partially neutralizes the electron space charge. The diode volt-ampere characteristics are computed and compared with experiments in the regime of small pd that produces a monotonic potential distribution between the cathode and the anode. The minimum value of pd necessary for a nonmonotonic distribution is found.

41130 **Gas discharges in planar, low-pressure thermionic diodes. II. Plasma regime.** Bromberg, L.; Smullin, L.D. (Plasma Fusion Center and Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *J. Appl. Phys.;* **50**: No. 4, 2634-2637(Apr 1979).

The theory and experiment of a one-dimensional low-pressure discharge is presented. The discharge current is provided by a thermionic cathode that operates space-charge limited. The primary electrons ionize the background gas and also heat the plasma electrons. The plasma characteristics (plasma density, electron temperature, and ion current density) and the discharge current are computed as functions of the discharge voltage and the neutral pressure.

The model is self-consistent and requires no experimentally determined parameters.

FUEL CELLS

REFER ALSO TO CITATION(S) 40090

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 40059

41131 (PB—285360) **Materials for fuel cells. Annual report, January 1977—December 1977.** Bennett, L.H.; Cohen, M.I.; Dragoo, A.L.; Franklin, A.D.; McAlister, A.J. (National Measurement Lab. (NBS), Washington, DC (USA)). Jul 1978. 133p. NTIS PC A07/MF A01.

The National Bureau of Standards has undertaken a program of research on materials for fuel cells and batteries. This program includes studies of electrocatalysis in liquid-electrolyte cells and of solid electrolytes, in high-temperature cells and in batteries. This report describes the results for the second year of the program. In most fuel cell applications a major contribution to the overvoltage, and therefore to a reduction in useful voltage and to efficiency, comes from electrode polarization. For use in hot H^3PO^4 no satisfactory substitutes for Pt have been found, but Pt is not completely satisfactory. In catalyst loadings sufficiently large to ensure adequate efficiency and lifetime it makes a significant contribution to the cost. At the anode its sensitivity to CO poisoning forces the use of higher temperatures and catalytic shift conversion in the fuel processing train. At the cathode a mixed potential situation seems to exist and the open-circuit voltage lies below what should be possible. Thus a continued study of electrocatalysis and electrocatalysts in H^3PO^4 is worthwhile. This program studies refractory metal-metalloid compounds (e.g., WC) as potential anode catalysts. Work on oxide catalysts for use at the cathode was suspended for lack of funds, but some effort has gone into automating the electrochemical measurements used in studying electrocatalysis of either kind. These two lines of work are reported here.

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

REFER ALSO TO CITATION(S) 41009, 41075, 41087

41132 (LBL—7893) **Another look at energy conservation.** Schipper, L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1978. Contract W-7405-ENG-48. 24p. (CONF-7808104—1). Dep. NTIS, PC A02/MF A01.

From American Economic Association meeting; Chicago, IL, USA (30 Aug 1978).

The need for energy conservation in US buildings, industry and the transportation sector, the effects of the amount and cost of energy supplies on energy conservation, and goals of a national energy policy are discussed. (LCL)

BUILDINGS

REFER ALSO TO CITATION(S) 40555, 41012, 41013, 41014, 41049, 41050, 41063, 41066, 41076, 41117

41133 (COO—4490-6) **Use of fluidized bed heat exchangers in heat pump systems for improved performance. Technical status report, 1 September 1978—31 November 1978.** Chen, J.C.; Sarubbi, R.G. (Lehigh Univ., Bethlehem, PA (USA)). Nov 1978. Contract EC-77-S-02-4490. 8p. Dep. NTIS, PC A02/MF A01.

Performance curves have been obtained for condenser heat output, evaporator heat input and overall coefficient of performance (COP) as a function of outdoor air temperatures ranging from 10°F to 50°F and at an indoor air temperature of 65°F. Both temperatures were controlled by recycling cold air from the evaporator exhaust and mixing it in the plenum. There is good agreement, within expected error bands, with available performance data for the York heat pump. In addition, this data has been used to obtain air side heat transfer coefficients ranging from about 9 to 6 BTU/hr°F for the evaporator and 1.5 to 2.5 BTU/hr°F for the condensor. These values are being used as a basis for the design of the fluidized bed heat exchanger. Plans for a separate test of the deicing capability of low temperature fluidized beds have been formulated.

41134 (LA-UR—79-625) **DOE-2 building energy analysis computer program.** Hunn, B.D. (Los Alamos Scientific Lab., NM (USA); California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1979. Contract W-7405-ENG-36. 11p. (CONF-790346—1). Dep. NTIS, PC A02/MF A01.

From Conference on conservation: energy management by design; El Paso, TX, USA (8 Mar 1979).

Concern with energy conservation requirements has resulted in a growing awareness throughout the architectural/engineering community of the need for an easy-to-use, fast-running, completely documented, public-domain computer program for the energy-use analysis of buildings. DOE-2 has been developed to meet these needs. The program emphasizes ease of input, efficiency of computation, flexibility of operation, and usefulness of output. A key factor in meeting these requirements has been achieved by the development of a free-format Building Design Language (BDL) that greatly facilitates the user's task in defining the building; its heating, ventilating, and air conditioning (HVAC) systems; and its operation. The DOE-2 program is described.

41135 **Thermal flue apparatus.** Patterson, T.W. US Patent 4,148,302. 10 Apr 1979. Filed date 5 Jul 1977. 4p.

A thermal shield device is provided for association with a flue extending from a combustion chamber and which shield device comprises a substantially U-shaped member comprising radially spaced inner and outer walls and with the shield being positioned parallel to the vertically extending flue and covering approximately 180° of the periphery thereof, normally between the flue and an adjacent wall, the flue being open ended and having a deflector collar or neck positioned at its upper end connecting to the open or hollow interior thereof for deflection of hot air rising through the shield out into the room, and with other deflector members being positioned intermediate the inner wall of the shield and the adjacent flue to deflect hot air rising along the flue periphery out into the room.

41136 **Supplementary heat control for heat pump system.** Garnett, J.V. (to Rheem Manufacturing Co.). US Patent 4,141,408. 27 Feb 1979. Filed date 16 Jun 1976. 4p.

A supplementary heat control for a heat pump system includes thermostatic sensors on the downstream side of the heat pump heating coil. The sensors upon sensing temperature differentials in the heated air stream which indicate the need for supplemental heat operate relays. The relays, in turn, activate power input to supplementary heating coils downstream from the thermostatic sensors. A plurality of sensors are disclosed for sensing differential temperature differentials and thus permitting staging of supplementary heat.

41137 **Power demand limiting circuit.** Briscoe, H.H.; Pillsbury, J.L. US Patent 4,141,407. 27 Feb 1979. Filed date 29 Mar 1977. 6p.

A power demand limiting circuit is disclosed comprising air temperature control apparatus coupled with a municipal source of electric current through a thermoresponsive switch, through a meter having means for measuring maximum power demand for any period in a succession of periods of preselected duration, and through a timer programmed to cycle a timer switch at least once during each of the periods, whereby the air temperature control apparatus is rendered incapable of demanding power continuously throughout any of the metered periods.

41138 **Energy conservation at the building scale: an innovation program.** Watson, D. (Yale School of Architecture, New Haven, CT). pp 705-708 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The activity of designing, constructing, and using buildings and its related energy infrastructure is central to the energy problem, because of the amount of energy required and energy produced and destined for the building sector is used wastefully whether due to poor design or construction or use habits. The case has been argued by many authors to the effect that a dollar spent in energy conservation at the building will save twice the energy produced by an equal investment in remote power plant capacity. To achieve substantial energy conservation at the building scale, existing buildings have to be renovated and new buildings designed with great sophistication. Unprecedented scale is required through the building industry. Possible characteristics of such an innovation program to move from conventional building practice to minimum energy building design are discussed under four major areas that determine the design criteria of energy use in buildings: land-use planning, energy infrastructures, construction method, and financing mechanisms. From the standpoint of net energy cost and the environmental considerations of waste disposal, future buildings and related building products should be designed for the longest life possible. It is noted that solar heating becomes practical at the scale of low-to-medium density building, where the existing roof areas are sufficient for at least solar domestic water installations. Innovations to improve environ-

mental quality and reduce energy use through building design are discussed: finance/planning, technical innovation, architectural design, and social innovation.

RESIDENTIAL BUILDINGS

REFER ALSO TO CITATION(S) 40499, 40505, 40563, 40564, 41035, 41047, 41048, 41052, 41058, 41077, 41092, 41115, 41118

41139 (BNL—50952) **Acoustic location of infiltration openings in buildings. Final report.** Keast, D.N. (Bolt, Beranek, and Newman, Inc., Cambridge, MA (USA)). Oct 1978. Contract EY-76-C-02-0016. 154p. Dep. NTIS, PC A08/MF A01.

Unnecessary air infiltration ("draftiness") in buildings can be a major cause for excessive energy consumption. A method for using sound to locate, for subsequent sealing, the openings of air infiltration leakage paths in buildings has been investigated. The results of pertinent analytical studies, laboratory experiments, and field applications of this acoustic-location method are reported; and a plan is provided to encourage national implementation of the method. Low-cost, readily available equipment and procedures are described whereby the average building contractor or homeowner can use acoustic leak location to pinpoint many of the air infiltration openings in a building.

41140 (LBL—8828) **Air leakage, surface pressures and infiltration rates in houses.** Grimsrud, D.T.; Sherman, M.H.; Diamond, R.C.; Sonderegger, R.C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1979. Contract W-7405-ENG-48. 12p. (CONF-790523—3). Dep. NTIS, PC A02/MF A01.

From 2. international CIB symposium on energy conservation in the built environment; Copenhagen, Denmark (27 May 1979).

A model is presented whose input is two sets of measurements: air leakage under fan pressurization; and natural pressure differences between indoors and outdoors. The output is the house's natural infiltration rate. The model was tested on six United States houses, three conventional houses located in a region of mild climate and three energy-efficient houses located in a cold winter region of the country. Good agreement was obtained between infiltration rates measured using a tracer gas and rates calculated from the model.

41141 (R—2278-DWP/NSF) **Los Angeles Senior Citizen Lifeline Electricity Rate.** Sullivan, T.J. (RAND Corp., Santa Monica, CA (USA)). Jan 1979. 108p. Rand Corp., Santa Monica, CA.

In November 1975, City Council passed an ordinance directing the Los Angeles Department of Water and Power to offer its low-income senior citizens a discount on electricity and water. This report examines the nature of that electricity discount and its effects on the energy used by eligible households. The special electric rate gave a 50% discount on the first 360 kWh of bimonthly consumption to customers age 62 or older with household incomes less than $7500. By summer 1977, more than 89,000 households were receiving lifeline discounts totaling over half a million dollars every month. This discount is called a lifeline rate because its goal is to enable senior citizens to purchase economically a basic amount of electricity believed necessary for sustaining a decent, though austere, standard of living. A lifeline household will save about $10 on an electricity bill if it consumes 360 kWh or more in two months. In the two-month period of march and April 1977, the lifeline rate discounts totaled $1,036,225. This report describes the objectives the program attempts to meet, analyzes its achievements and failings, and compares them with the predicted performance of several hypothetical policy alternatives.

41142 **Heat-pump-heated house with cold air control circuit.** Vinz, S. (to Deutsches Patentamt, Muenchen (Germany, F.R.)). German(FRG) Patent 2,644,372/A/. 6 Apr 1978. 5p. (In German).

Design and arrangement of radiators for space heating with the aid of a heat pump are described. The arrangement of the radiators, which are insulated from the walls (pre-fabricated concrete elements), permits a special air guidance. This air guidance makes it possible to utilize the waste heat of the room via the heat pump. The special air guidance is facilitated by additional window panes in close connection with the radiators.

41143 **Load-shifting techniques for home refrigerators.** Beyea, J.; Weatherwax, R. (Princeton Univ., NJ). pp 121-132 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The authors examined the feasibility of installing a number of load-shifting devices in home refrigerators, including: (1) nighttime defrost for automatic-defrost units, and (2) ice cooling of the refrigeration section during the day. Benefits to the customer (under an experimental peak-load pricing schedule being tested in New York State's Con Edison franchise district) were compared with system savings. Although the total system savings to Consolidated Edison would be significant, the savings in generation costs would be surprisingly small (due to mismatching of seasonal refrigeration load curves and seasonal generation costs). Thus, if the goal of a peak-load pricing schedule is to reduce the need for new plants or produce a shift to base-load plants, it is important to match the pricing schedule to the relevant marginal costs. However, this may not be feasible, suggesting the need for non-market incentives to encourage optimum load-management strategies.

41144 **Philips experimental house: results and experience.** Bruno, R.; Hermann, W.; Hoerster, H.; Kersten, R.; Klinkenberg, K.; Mahdjuri, F. (Philips Research Lab., Aachen, Germany). pp 299-304 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Within the energy research program of the Federal Republic of Germany, a study was made on measures of energy conservation and utilization of solar energy in buildings. The goal of this study was to evaluate various measures of reducing the energy needs of buildings. As a part of the experimental program, an experimental house (modified prefabricated) was constructed in 1974. Included in this house were the following measures: extensive improvement of the heat insulation of walls and windows, controlled air ventilation, heat recovery from exhaust air and waste water, use of heat pumps in several modes of operation, and utilization of solar energy via evacuated selective solar collectors. From 1975 to 1977 the data (150 channels) referring to the effect of these measures were found by using a P855 minicomputer. The minicomputer was also used to simulate the internal loads as defined by a family of four and their energy habits.

41145 **Impact of environmental control on residential energy-use management.** Woods, J.E.; Peterson, P.W. (Iowa State Univ., Ames). pp 305-312 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Because of the energy-intensive nature of the more-developed populations, the scope of this paper concentrates on residential energy consumption in these sectors. To manage the energy consumed for residential environmental control, both passive and active methods must be considered. The relative importance of these factors is being studied in an Energy Research House (ERH) now under construction at Iowa State University. Passive methods to reduce energy consumption in the ISU energy research house utilized are: control size and shape of house, select material to capitalize on thermal mass and resistance characteristics, orient house to maximize solar gain in winter and minimize in summer, shade windows in summer and allow direct radiation in winter, and landscape with berms, deciduous trees and vines. Active methods to reduce energy consumption in ISU energy research house utilized are: select efficient mechanical heating and cooling systems, employ active solar energy systems, select energy efficient household appliances, develop control systems for load leveling and optimization of system operation, and develop efficient ventilation systems. Various housing starts in Ames were compared for annual energy requirements; some were built according to HUD Minimum Property Standards and ASHRAE Standards. (MCW)

41146 **Control applications for energy management.** Tobias, J.R.; Anderson, P.A. (Honeywell Inc., Minneapolis, MN). pp 313-316 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Over the past 90 years, house heating has evolved from wood and coal space heaters (fireplaces and stoves) to centralized forced-air year-around air-conditioning systems. The form of the environmental conditioning unit has been determined by the abundance of fuel and desire for automatic comfort control. The current shortage of conventional fossil fuels will probably drive the systems toward those using more electricity. The desire for reasonable comfort is as strong as the desire to use minimum energy and is placing demands on controller requirements that did not exist in the past. This paper discusses the conventional approaches to control that existed prior to today's need for energy conservation. Then the characteristics of present controllers used for energy savings are described. The controllers provide the capability for furnace control, night setback, zoning, and ventilation. From this current base, the future in residential environmental control is projected. The types of control systems that will be developed are based on the need of minimizing the use of precious fuels while maintaining reasonable comfort and a healthy environment.

41147 **Application of thermal energy storage in residential air conditioning.** Jones, J.W.; Small, T.J. III. (Univ. of Texas, Austin).

pp 317-324 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The application of thermal energy storage in residential air conditioning has significant potential for energy-use management. Its advantages lie in the possibility of reducing summer peak demand for electricity and in improving air-conditioning-system performance. The concept is simple: thermal storage is used as a means of shifting the operation of the air-conditioning-system condensing unit from the peak electric-use and higher-temperature afternoon hours to a lower-temperature, low-utility-demand period during the night and early morning hours. The thermal storage options applicable to residential air conditioning are discussed briefly, and two systems suitable for use in hot and hot-humid climates are described in detail.

41148 Rehabilitation and energy conservation. Hartkopf, V.; Goodspeed, C.H. (Carnegie-Mellon Univ., Pittsburgh, PA). pp 719-731 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

During the 1975-76 and 1976-77 academic years the graduate multidisciplinary program in Advanced Building Studies focused on energy-conscious rehabilitation of existing neighborhoods through the project courses. Two case studies were conducted. One concerns the reconstruction of vacant duplex; the other, the design of a minimal energy dwelling on a vacant lot. The aim of this paper is to present information on energy-efficient rehabilitation and to summarize major findings from the case studies. Presently, the program is expanding its perspective to investigate all aspects of proto-typical minimal energy dwellings applicable for Pittsburgh's rehabilitation. The program is supported by a grant from the National Science Foundation.

OFFICE BUILDINGS

REFER ALSO TO CITATION(S) 41152

SCHOOL, MUNICIPAL AND OTHER PUBLIC BUILDINGS

REFER ALSO TO CITATION(S) 41035, 41046, 41053, 41073, 41152

41149 (CONF-7804123—1) **University of Kansas energy forest.** Naughton, G.G.; Geyer, W.A.; Gould, L.K.; Strine, J.H. (Kansas State Univ., Manhattan (USA)). 1978. Contract ET-78-G-01-3042. 14p. Dep. NTIS, PC A02/MF A01.

From 110. annual meeting of the Kansas Academy of Science; Lawrence, KS, USA (14 Apr 1978).

A previous study established the feasibility of converting the central steam generating plant on the University of Kansas campus from natural gas or oil to solid waste fuel, but that there would be a potential 15% shortage in Btu's of fuel from the solid waste available. This study was initiated to determine if wood wastes or wood grown specifically for fuel use could make up that deficiency. The availability of forest, industrial, and urban wood wastes was determined, the cost of fuel wood plantations was estimated, and the impact of municipal waste combustion on landfill operations was studied. It was concluded that the available supply of waste wood is more than adequate to meet the top-off fuel requirements for a solid waste-fired steam plant and that the cost of these wood fuels would be from 56 to 80% of the current cost of natural gas. (LCL)

COMMERCIAL AND INDUSTRIAL BUILDINGS

REFER ALSO TO CITATION(S) 41016, 41052, 41053, 41057, 41072

41150 Roof spray cooling: an inexpensive, yet effective option for reducing cooling costs. Norco, J.E. (Solar Cool, Inc., Oak Brook, IL). pp 207-213 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

In many buildings, depending upon the geographic location, roof insulation, and internal heat generation, roof spray systems can cut the total cooling load by as much as 50%. Ideal candidates for roof spraying include 1- to 3-story commercial and industrial buildings with poorly insulated roofs. Intermittent roof spray systems consist of a network of piping, strategically placed spray heads, and a central controller which activates the system based on roof temperature sensors. As energy costs for cooling increase, the attractiveness of evaporative roof spray cooling is enhanced. Computer analyses of the economics of roof spray systems indicate that they will produce payback periods less than 5 years and in many cases less than 3. In addition to saving air-conditioning operating costs, considerable reductions can be realized in the capital investment of air-conditioning equipment in new buildings. Roof spray systems can offset a significant fraction of the installed capacity with very large resultant savings. This paper discusses the use of intermittent roof spray systems, including hardware, operations, effectiveness, and economics. A computer program developed to evaluate roof spray systems is discussed, and data taken on an experimental roof spray installation is presented.

41151 Door/wall air curtain systems. Nemes, G. Jr. (George Nemes and Associates, Ferndale, MI). pp 225-228 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Traditional heating and ventilating system design standards have allowed extensive and wasteful heating and ventilating losses through the building structure, such as glass, walls, and roof. The present approach to the design of the heating and ventilating systems must be re-evaluated and re-analyzed. This re-evaluation is necessary to eliminate the excessive heat losses, over-sizing of heating and ventilating equipment and overlapping functions of heating and ventilating equipment. A new design concept was developed, whereby considering the total building envelope as a single cube, and whereby introducing heating, ventilation, and make-up air near the building floor level and at the perimeter wall of the building appeared to be the best solution to obtain the objectives to reduce the use of energy and to conserve energy.

41152 Economically rational energy-conservation program for institutional buildings. McClintock, M. (Boston Univ, MA). pp 275-284 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

A methodology is developed that allows generation of an optimum energy-conservation program primarily, but not solely, suited to institutional buildings. The method has the flexibility to allow assessment of (1) technical improvements to the building structures, (2) changes in maintenance and operation policies, (3) alternative energy technologies, and (4) educational aspects of energy conservation for administrative staff, maintenance and operational personnel, faculty, and students. The result of its application is an ordered conservation program in which savings realized from the first measures are used to underwrite the cost of later measures, and it is therefore possible to pay for a large part of the program out of cash flow rather than necessitating capital fund-raising programs. Once instituted, of course, many energy-conservation measures continue to save long after they have been paid for. An economically rational energy-conservation program therefore has the potential to provide some of the highest returns on investment at the present time, and the method shows how to evaluate this properly.

TRANSPORTATION

REFER ALSO TO CITATION(S) 41059, 41066, 41117

41153 (ORNL/EIS—146) **Transportation Energy Conservation Data Book: a selected, annotated bibliography, Edition 3.** Ehrenshaft, A.R.; Barber, B.Y.; Carroll, P.J.; Plemons, L.K.; Purnell, P.A.; Weaver, R.S. (Oak Ridge National Lab., TN (USA)). Nov 1978. Contract W-7405-ENG-26. 283p. Dep. NTIS, PC A13/MF A01.

As a companion volume to the Transportation Energy Conservation Data Book, Edition 3 (ORNL-5493), this bibliography provides references on energy consumption by major transportation modes; conservation alternatives; research, development, and demonstration of alternate modes of transportation and fuels; and other factors influencing energy utilization in the transportation sector. Reviews of ten selected studies documenting energy use by different transportation modes are included in this bibliography. Reports sponsored by the Department of Energy, Division of Transportation Energy Conservation, are listed in a separate section. These references are also included in the main bibliography. The 819 references contained in this bibliography are an update of Transportation Energy Conservation Data Book: a selected, annotated bibliography, Edition 2 (ORNL/EIS-114 (Part 2 of ORNL-5320)).

41154 Framework for evaluating energy savings from urban transportation. Mudge, R.R. (Congressional Budget Office, Washington, DC). pp 431-435 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The framework first categorizes the major components of urban-transportation energy consumption. It then briefly describes how this framework has been applied by the Congressional Budget Office and summarizes the results of similar analyses by other

researchers. The transportation of people in urban areas consumes about 10% of the nation's energy and about one-fourth of its petroleum. Nine basic energy components of urban transportation are described (propulsion energy per vehicle-mile, average number of occupants, station and maintenance energy, construction energy, vehicle manufacturing energy, mode of access, fraction of trip devoted to access, circuity, and source of new patronage). These nine components are combined to form a hierarchy of four measures of energy use, in which each measure has an increasing level of comprehensiveness. These four levels are energy intensiveness, line-haul energy, modal energy, and program energy. Two conclusions stand out. First, the most-energy-efficient modes are typically those with a high average load factor such as vanpool and carpool. Second, largely due to access energy and the relatively few people attracted from single-occupancy autos, the typical new rail system may even lose energy. Older rail systems that were built under different conditions than today, are relatively energy-efficient. (MCW)

41155 Energy and the city. Bacon, E.N. (Mondev International Ltd., Montreal, Canada). pp 745-748 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The growing shortage of fossil fuel will result in replacing gasoline with electricity as the principal motive power for transportation. The resulting loss of individual mobility will cause a reclustering of dense urban development along electrically-driven transportation lines. Human energy, aided by the bicycle, will become the power source for micro-movements.

41156 Energy analysis and environmental analysis in transportation planning. Lavine, M.J.; Meyburg, A.H. (Cornell Univ., Ithaca, NY). pp 859-874 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

This paper illustrates an analysis strategy based on some theories about energy flow bezng used in research on environmental assessment of transportation projects. The analysis strategy includes measuring energy flow not only in transportation and related economic systems, but also in related natural systems. The energy-flow theories may help us understand how to use the energies of the environment to gain maximum effect for us. The natural environment includes many energies that we may use. To a great extent, modern industrial systems have operated and grown using energies from fossil fuels. As it becomes more costly, in both monetary and energy terms, to use the energy of fossil fuels, it may become increasingly advantageous for us to make greater use of the renewable energy resources from nature. Energy-flow theories are used in this paper to illustrate an analysis strategy for getting maximum effect by mixing renewable natural energy flows with those already operating in our economic systems. Analysis of an example case study reveals that further preservation of natural systems may result in a net increase of work accomplished in the study region.

AIR AND AEROSPACE

41157 (CONF-7705162—) **Place of aviation in society.** (Royal Aeronautical Society, London (UK)). 1977. 376p. Dep. NTIS (US Sales Only), PC A17/MF A01.

From 15. Anglo-American aeronautical conference; London, UK (31 May 1977).

Twenty-two papers were presented at the meeting. A separate abstract was prepared for one paper. The remaining 21 papers were not in scope for the data base. (LCL)

41158 (CONF-7705162—, pp 1-30) **Have energy, will travel.** Allen, J.E. (Hawker Siddeley Aviation, Kingston, Jamaica). 1977.

From 15. Anglo-American aeronautical conference; London, UK (31 May 1977).

The problem of availability of alternative aircraft fuels in the future is discussed. The effects of the following alternative strategies are examined: diversion of oil for premium transport use; new generations of low fuel-use aircraft; transference to kerosene synthesized from coal or shale; world-wide introduction of liquid hydrogen for aircraft; and some other possibilities.

41159 Energy scenarios for the future of air transport. English, J.M.; Smith, J.L. (Univ. of California, Los Angeles). pp 457-465 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Changing supplies of various forms of energy will impact air transportation. As primary petroleum supplies are depleted, coal and oil shale will have to be substituted. However, it is not clear which sectors of the economy will be called upon to substitute new synthetic fuels. Besides economic questions, there are distinct disadvantages associated with use of synthetic fuels in the modern jet airplane - specifically, increased aromatics and higher freezing temperatures. On the other hand, conservation measures related to automobile performance may make more fuel available to aviation while, at the same time, increasing air-travel demand. In order to assess the influences of this changing energy supply on air tranport, it is necessary to predict affects on the other energy sectors. The objectives of the study, being long-range, necessitate the use of scenarios that depict plausible futures. Five economic scenarios are developed. Of these, a modest economic growth case, and an interrupted economic growth caused by failure to meet basic energy needs, appear most plausible. In context with these general scenarios, various aviation scenarios are then elaborated.

RAILWAY

41160 Energy consumption of rail rapid transit: an analysis of the BART experience. Ellis, R.H; Sherret, A. (Peat, Marwick, Mitchell & Co., Washington, DC). pp 397-417 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

This paper documents and analyzes the operating energy consumption of the San Francisco Bay Area's new rapid-transit system; it briefly compares BART's energy consumption with that of other rail rapid-transit systems and includes a partial analysis of energy consumption of BART, bus, and automobile in one travel corridor of the Bay Area using recent data on actual passenger volumes. Components of operating energy in BART that are considered are: station energy, maintenance energy, and traction energy. Basic conclusions are: in terms of energy consumed per seat-mile provided, BART is less fuel-efficient than bus but much more efficient than automobile; and in a major travel corridor of the Bay Area where much of BART's ridership come from buses, where automobile occupancy is high, and where BART's load factors in the peak period/reverse direction and off-peak are low, the actual energy savings due to BART are much smaller than the potential. And if the many new trips apparently induced by BART are taken into account, the net energy savings may be negligible. (MCW)

41161 Public transportation: PATH as an example. Smith, D.T. (One World Trade Center, New York, NY). pp 419-429 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

The PATH rail-transit system (Port Authority Trans-Hudson system) is a 14-mile long, 70-year old heavy rail rapid-transit system operating in the New York metropolitan area. The operational and technological programs to conserve energy in the last few years are described. The paper first concentrates on PATH itself, based largely on propulsion energy and utilization of the system. The second part reflects regional perspectives. PATH's primary energy source is electricity. Only insignificant amounts of other energy are consumed, primarily space heating at various maintenance facilities or for use in various vehicles operated by PATH. Data are sparse that identify the energy effectiveness of other rail-transit systems for peak versus off-peak services; but with some data, comparisons are made with PATH performance - other systems in the Northeast and some foreign systems. The simplest and quickest way to improve rail-transit's Btu-per-passenger-mile effectiveness is to adopt policies that would increase its utilization, the author says. (MCW)

41162 Intercity railroad energy conservation. Moon, A.E. (Stanford Research Inst., Menlo Park, CA). pp 467-480 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Although intercity freight railroading accounts for just over 3% of transportation petroleum fuel use in the United States, energy-conservation measures are nevertheless an attractive investment for the railroad industry, which uses only a small number of locomotives to provide motive power. The paper describes the patterns of energy use in intercity freight railroad transportation and identifies energy-conservation measures that can be taken in the following areas: (1) operations - improved fuel and train handling, reduction of locomotive idle time, planning individual train consists; (2) equipment design and technology - diesel locomotive waste heat recovery, energy storage and regeneration, lighter weight equipment; (3) regulation - consideration of energy conservation in regulatory proceedings; and (4) intermodal systems and modal choice - rationalization of transportation modal use in intercity freight transportation, truck-

rail intermodal system development, and implementation of measures that will make railroad service more useful to shippers.

LAND AND ROADWAY

REFER ALSO TO CITATION(S) 40321, 41186

41163 (TID—29373) **Air leakage in refrigerated vans. report of correlation test data.** (Bodenheimer (B.A.) and Co., Inc., Stamford, CT (USA)). Nov 1978. Contract EC-77-C-02-4338. 194p. Dep. NTIS, PC A09/MF A01.

Data are presented which were obtained from air leakage tests on 92 different vehicles representative of the refrigerated transportation fleet in the U.S. The data are not evaluated. (LCL)

SEA AND WATER

41164 **Analysis of energy-conservation opportunities in the domestic and international marine-transport industry.** Donovan, L.J.; Gregory, R. (Booz, Allen & Hamilton Inc., Bethesda, MD). pp 449-456 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

This paper provides a summary energy analysis of the US marine transportation industry. It is based on work performed in conjunction with a study of Energy Use in the Marine Transportation Industry, Vol. I-IV for the Energy Research and Development Administration, by Booz, Allen & Hamilton Inc. It defines the industry in terms of operating or service sectors and energy use. Energy-conservation opportunities in the areas of government regulation and technology are discussed. This analysis includes all powered waterborne craft, with the exception of those owned or operated by a government organization and fixed-offshore-production platforms.

PIPELINE

41165 **Energy-conservation opportunities in pipeline operations.** Banks, W.F. (Systems, Science and Software, La Jolla, CA). pp 437-448 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Results are presented of a DOE study of the susceptibility of the pipeline transportation industry to energy-conservative technological innovations. Estimates were developed of energy consumption in the pipeline industry. The pipeline model developed is a dynamic simulator, accepting as inputs the physical and financial parameters of the system, and a market (throughput) projection, and yielding as outputs all the important energetics and economics parameters. Government regulation of the industry was reviewed and recommendations were formulated for regulatory changes that would conserve energy. The political and economic issues underlying the controversy over coal slurry pipelines were reviewed. More than twenty candidate energy-conservative technological innovations were assessed, and eight were recommended for further study that would possibly culminate in demonstration programs. Particular attention was given to six of those efficiency improvements which would have wide applicability for energy conservation in other segments of the transportation industry and in the electric utility industry. Finally, a baseline scenario for the future is defined, based upon the conventional wisdom of the industry. Then, an unconventional scenario is developed, involving introduction of freight pipelines that would transport both dry bulk commodities and packaged freight, and that, by inducing modal shifts between transportation modes, would result in a reduction of total transportation energy consumption and would be conductive to evolution of high-speed rail transport of both freight and passengers.

INDUSTRY AND AGRICULTURE

REFER ALSO TO CITATION(S) 41056, 41060, 41061, 41102, 41117

MATERIALS

41166 **Hot-beef boning for energy conservation.** Henrickson, R.L. (Oklahoma State Univ., Stillwater). pp 491-494 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Boning the warm bovine carcass following a post-mortem conditioning period appears to have many economic advantages. Only the edible portion of the carcass would be cooled, thus reducing the needed energy and the cooling period. Nearly all published research indicated that quality attributes other than tenderness are not adversely affected. When the bovine carcass is suspended from a rail, some of the muscles are under great tension while others are forced to contract. Minimization of this condition can be achieved through boning. Some tension during the conversion of muscle to meat appears to be desirable to achieve tender meat. Since rigor mortis cannot successfully be blocked, it is desirable to leave the muscles attached to the bones during this conditioning period. Work to date suggested that three hours at 15°C may be adequate to achieve practical tenderness, particularly since mechanical methods for making meat tender are readily available. On-the-rail boning of the warm carcass will reduce air exposure time to spoilage bacteria. Surface counts of the carcass parts and plate counts of ground beef both indicated that product contamination would be small. Significant savings in refrigeration capacity, storage space, and transportation costs are forecast with attendant energy reduction.

EQUIPMENT AND PROCESSES

REFER ALSO TO CITATION(S) 40558, 40559, 40560, 40561, 40562, 41066, 41069, 41070, 41071, 41074, 41457, 41729

41167 **Method and device for controlling the energy consumption in a pulp refining system.** Floden, M. (to Defibrator Aktiebolag). US Patent 4,148,439. 10 Apr 1979. Priority date 30 Jan 1976, Sweden, 4p.

The invention discloses a method and apparatus for coordinating the rate of feed and the moisture content of the pulp material to the heat quotients of the mechanical energy input in a refiner system in which the moisture-containing pulp material is introduced at an adjustable rate of feed into the central portion of an axially adjustable grinding space defined between a pair of grinding discs which rotate relative to one another within a closed housing and in which grinding space the material is propelled by centrifugal force created by the rotation of the discs in an annular radial path toward the periphery of the discs while being subjected to a grinding operation in an environment of steam generated by the heat produced by friction in the grinding space. The heat quotients of the mechanical energy are sensed as the pulp material progresses along its radial annular path in the grinding space and the rate of feed and moisture content of the material and the width of the grinding space are coordinated to the sensed heat quotients to produce pulp of optimum values with minimized consumption of mechanical energy.

41168 **Reduction of energy in wet corn milling.** Krochta, J.M.; Look, K.T. (Dept. of Agriculture, Berkeley, CA). pp 495-502 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Wet corn milling is an energy-intensive process due to the need to dry and concentrate the resulting products. Modest increases in dewatering efficiency and dryer efficiency could produce energy savings of 18% and 14%, respectively. In addition, modifications to the steeping pretreatment before milling could reduce or eliminate the energy requirement for steep-water concentration, with energy saving up to 17%. 21 references.

41169 **Performance evaluation and improvement in industrial boilers and process heaters.** Schmidt, P.S. (Univ. of Texas, Austin). pp 631-641 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

This paper, primarily aimed at plant engineers and managers who are not specialists in combustion equipment, discusses a number of considerations in evaluating boiler and process-heater performance and in implementing programs to improve this performance. The various factors influencing performance are defined and discussed, and a simple method for estimating boiler efficiency is outlined. Some problems in the measurement of efficiency-related parameters are considered.

WASTE HEAT RECOVERY AND UTILIZATION

REFER ALSO TO CITATION(S) 41051, 41068, 41110, 41478

41170 (HCP/M/8688—01) **Guidelines for developing state cogeneration policies.** (Resource Planning Associates, Inc., Washington, DC (USA)). Apr 1979. Contract EM-77-C-01-8688. 122p. Dep. NTIS, PC A06/MF A01.

This document contains a set of guidelines for use by state decision makers in establishing policies regarding industrial cogeneration. By providing state officials with means of assessing the state potential for future cogeneration development and identifying state

actions to stimulate development, these guidelines increase the state decision makers' understanding of the critical issues surrounding cogeneration development in their state. The guidelines address a broad range of topics, including types of cogeneration technologies and their applications, technical constraints to cogeneration development, economic constraints accounting for the regulatory and institutional factors that inhibit cogeneration capital investments, and various ownership and operating arrangements that can promote cogeneration development. The document is structured to reflect a general process that must be followed before effective policy decisions at the state level can be made. Briefly, this process consists of three steps: understanding the concept of industrial cogeneration; assessing the potential for its development without state action; and identifying and evaluating possible actions to stimulate additional development.

41171 (ORNL/TM—6794) **Analysis of a cordierite (MAS) recuperator from a molybdenum heat-treating furnace.** Weber, G.W.; Tennery, V.J. (Oak Ridge National Lab., TN (USA)). May 1979. Contract W-7405-ENG-26. 48p. Dep. NTIS, PC A03/MF A01.

Recuperators which can transfer waste heat from industrial furnaces to the combustion air can result in fuel conservation. Available alloys cannot currently satisfy the demand for higher thermodynamic efficiencies from higher temperature recuperated combustion air because of their properties at high temperatures. Therefore, selected ceramic materials are principal candidates for use in waste-heat recovery devices for flue gas temperatures of 1100 to 1650°C. A leading configuration now under investigation is the cross-flow fixed-boundary extended-surface ceramic honeycomb heat exchanger. The need for a material that has both low thermal expansion and high thermal shock resistance and is also fabricable and relatively inexpensive has led to the development of cordierite (magnesium aluminosilicate - MAS). A cordierite honeycomb recuperator was exposed for about 2200 h to representative process temperatures from 1100 to 1550°C in a molybdenum and tungsten reheating furnace. This recuperator performed satisfactorily for test and exhaust inlet temperatures of 1100 to 1400°C. Electron microprobe and ceramographic examination demonstrated that molybdenum and tungsten carryover in the waste gas stream significantly penetrated the cordierite at temperatures as low as 675°C. The leading edges of the exhaust inlet section showed significant microstructural modification. A subsequent accidental overfiring to 1560°C resulted in slumping of this modified material. Exhaust-to-air channel leakage caused deposits in air channels and modified the microstructure in bonding lines between layers in the honeycomb. Cracking also occurred in the air outlet section. Significant microstructural modification, including coarsening within the walls and glass formation on the air-channel wall surfaces, was observed.

41172 (PB—287373) **Power plant waste heat utilization in aquaculture. Semi-annual report, No. 2, 1 November 1977—1 June 1978.** Guerra, C.R.; Godfriaux, B.L. (Public Service Electric and Gas Co., Newark, NJ (USA). Research and Development Dept.). Jun 1978. 181p. NTIS PC A09/MF A01.

The principal objective is to evaluate, at proof-of-concept scale, the potential of intensive aquaculture operations using power plant thermal discharges to enhance productivity. The field experiments involve the rearing of rainbow trout (Salmo gairdneri), channel catfish (Ictalurus punctatus) and American eel (Anguilla rostrata) for successive periods (semi-annual) in accordance with the temperature of the thermal effluents. Striped bass (Morone saxatilis) and the freshwater shrimp (Macrobrachium rosenbergii) are also being tested in smaller, laboratory size culture systems. The above mentioned species were selected because of their economic importance. They will be evaluated for food quality and marketability with the cooperation of potential commercial users. Aquaculture facilities were constructed at a steam electric generating plant for studies determining use for waste heat released into condenser cooling water. Growth rates, food conversion ratios, disease problems and mortality rates are being studied in the project. (Color illustrations reproduced in black and white) (Portions of this document are not fully legible)

41173 **Secondary energy resources for the production of malt.** Popv, V.E.; Starechus, P.A. *Fermentn. Spirt. Prom-st.;* No. 6, 21-25(1978). (In Russian).

An examination is made of the basic sources of waste heat which might be used for reducing fuel expenditure, such as the heat from grain germination, furnace gases from the malt dryer, and moist air from the dryer. Both Soviet and foriegn recommendations are cited for using waste heat and for more efficient malt drying operations. 5 figures, 5 references

INDUSTRIAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 40100, 40131, 40229, 40230, 41034

41174 **Conserving energy through used oil recovery and recycle: a plan for metropolitan Alabama.** April, G.C.; Wilborn, G.J. University, AL; Univ. of Alabama (1977). 15p.

Used oil recycling in Alabama could result in the conservation of 17 million gallons per year of automotive and industrial oils or 2 x 10^{12} Btu of equivalent energy. The non-commercial sources of used automotive oil and ways of conserving the associated energy value through a recycling program are discussed. Included are basic guidelines for the establishment of programs in 11 metropolitan areas of Alabama which could account for over 40% of the total used oil in Alabama or over 60% of the automotive used oil. Survey data illustrating that Alabama is a prime candidate to successfully implement a program, and reference to a model used oil recycling act are also included. Results of a metropolitan area survey for Tuscaloosa, Alabama, are also presented.

MUNICIPALITIES AND COMMUNITY SYSTEMS

REFER ALSO TO CITATION(S) 41020, 41021, 41022

PUBLIC UTILITIES

REFER ALSO TO CITATION(S) 41047, 41048, 41049, 41050, 41052, 41053, 41079

41175 (ANL/ICES-TM—32) **Energy-supply options for Soldier's Grove, Wisconsin. A summary of recommendations.** Kron, R.; Davis, A.; Davis, H.; Kennedy, A.S.; Bauer, P.; Hrabak, R.; Tschanz, J.F.; Voelker, J. (Argonne National Lab., IL (USA)). Feb 1979. Contract W-7405-ENG-38. 27p. Dep. NTIS, PC A03/MF A01.

This report presents ANL's findings on energy supply options for Soldier's Grove, Wisconsin. Thirteen energy supply systems were considered. Although any of the systems could be used--at a price--Argonne recommends the new downtown be supplied by a wood-fired central heating plant with steam distribution. Although a list of the less desirable systems is provided, full details have been omitted here, but will be included in ANL's final report.

41176 **Overview of urban energy systems technology options.** Marciniak, T.J.; Holtz, R.E. (Argonne National Lab., IL). pp 819-825 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

This paper gives a brief overview of the technologies involved in urban energy systems. Thermal efficiencies of urban energy system options are given for conventional (electric, thermal); district heating; total energy; selective energy; and integrated. A partial listing of current technologies (components) available for use in an urban energy system includes diesel engines, gas and steam turbines, combined cycle plants, electric generation, central chillers, boilers, heat pumps, thermal storage, and solid waste incineration. A partial listing of emerging technologies includes fuel cells, closed cycle gas turbines, organic Rankine cycle engines, ACES, electric compressed air storage, solid waste pyrolysis, methane production, solar thermal, and coal gasification and liquefaction. Advanced technologies that were reviewed included advanced Rankine cycle, Minto wheel, Sterling engines, electrochemical storage, advanced fuel cells, and solar photovoltaics. (MCW)

MUNICIPAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 40473, 40474, 40475, 40476, 40477, 40478, 40479, 40480, 40481, 40791, 41648

41177 (SAND—79-0182, pp 21-26) **Keynote address: Federal overview of municipal sludge management.** Hathaway, W.B. (Environmental Protection Agency, Dallas, TX). Feb 1979.

From Sandia irradiator for dried sewage solids seminar and dedication; Albuquerque, NM, USA (18 Oct 1978).

The proper disposal of sewage sludge is becoming an increasing problem on solid waste management systems throughout the country. Currently 18,000 municipal wastewater treatment plants are generating about 5 million tons of sludge a year. This is expected to double in the next 8 to 10 years. The environmental aspects of sludge disposal are discussed.

41178 **Condensation cleaning of exhaust gases.** deVries, E. (to QUAD Corp.). US Patent 4,141,702. 27 Feb 1979. Filed date 11 Jul 1977. 6p.

Exhaust gases, such as those produced by the incineration of municipal refuse, are cleaned by water scrubbing the gases in an open tower and thereafter further cooling the gases by heat ex-

change to condense water vapor and to trap and remove particulate material and other contaminants. Fouling and plugging of the heat exchanger during the condensation step is avoided by use of a spiral flow-cross flow type of heat exchange element.

EDUCATION AND PUBLIC RELATIONS

REFER ALSO TO CITATION(S) 41025, 41105, 41115, 41148

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

REFER ALSO TO CITATION(S) 41100

41179 (UCRL—52553(Vol.1)) **Energy storage systems for automobile propulsion: 1978 study. 1. Overview and findings.** Berhrin, C.J.; Anderson, C.J.; Bomelburg, H.; Farahat, M.; Forsberg, H.C.; Hudson, C.L.; Kullman, B.C.; O'Connell, L.G.; Strickland, G.; Walsh, W.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Dec 1978. Contract W-7405-ENG-48. 57p. Dep. NTIS, PC A04/MF A01.

A technical and cost analysis of energy-storage devices and energy-storage power systems for automobiles as well as an analysis of the national energy impact with the introduction of such automobiles were performed. The goal was to determine which devices and power systems are likely to provide credible alternatives to current and future internal combustion engine propulsion systems between now and the year 2000. The work was coordinated with results of the study team's work on this subject in prior years. Study panels continued to examine electrochemical, mechanical, chemical, and thermal storage devices with the purpose of identifying and selecting the most promising. These devices were used in conceptual designs of various energy storage propulsion systems. Their resultant performances and costs were calculated and compared against each other and against a baseline ICE vehicle system conceptually designed to provide the same performance. Using results of the study reported at the end of FY 1977 (see ERA 3:33359 and 3:31300), the FY 1978 study concentrated on examining the following: the effect on all-battery electric systems of optimizing batteries for the specific peak power and specific energy relationship, the effect on the relative results of using highly optimistic (10% confidence level) component characteristics; the national energy impact of the future introduction of energy storage automobiles; and the effect on prior results and conclusions of R and D achievements in the past year.

INTERNAL COMBUSTION ENGINES

REFER ALSO TO CITATION(S) 41187, 41189, 41190

41180 **Fuel reforming system for an internal combustion engine.** Noguchi, M.; Bunda, T.; Tanada, T. (to Nippon Soken, Inc.). US Patent 4,147,136. 3 Apr 1979. Priority date 6 Dec 1974, Japan, 24p.

The fuel reforming system for an internal combustion engine has a fuel reforming reactor to be supplied with a hydrocarbon fuel. The reactor contains a catalyst carrier and a catalyst thereon to be heated for facilitating a conversion of the fuel into a reformed gaseous mixture rich with hydrogen which mixture is to be fed into the engine. The catalyst is periodically alternately exposed to the fuel and air so that carbon produced and deposited on the catalyst during the fuel reforming reaction facilitated by the catalyst is burnt away from the catalyst carrier and the catalyst thereon whereby the catalytic performance of the catalyst is restored to ensure a prolonged operative life thereof. The reformed gaseous mixture assures a reliable ignition and combustion of a mixture thereof with air in the engine at a very lean air-fuel ratio to advantageously decrease the emission of harmful commponents of engine exhaust gas.

41181 **Carburetor fuel flow control.** Dye, S.O. (to ACF Industries, Inc.). US Patent 4,141,940. 27 Feb 1979. Filed date 27 Dec 1977. 10p.

A staged carburetor comprised to a carburetor body having an inner induction passage with a venturi there-within and an outer induction passage encircling the inner induction passage is described. A fuel circuit has an outlet at the venturi. A fuel metering rod extends transversely of the induction passages and has a variable diameter end portion projecting into the outlet. The metering rod moves relative to the outlet to vary the quantity of fuel delivered and has an enlarged diameter section intermediate its length which further reduces the cross-sectional area of the inner induction passage at the venturi and increases the pressure drop created thereat. An air valve positioned in the outer induction passage normally closes the passage whereby air is initially drawn into the engine only through the inner induction passage. Increased demand for air results in an opening force being exerted on the air valve to open it so air is drawn into the engine through both induction passages. The air valve is linked to the metering rod to move it relative to the outlet as the air valve opens and change the quantity of fuel drawn into the inner induction passage. Atmospheric air is bled into the inner induction passage to modulate the pressure drop created and control the air-fuel ratio of the mixture produced in the induction passages.

41182 **Early fuel evaporation carburetion system.** Marcoux, L.; Berg, P.G. (to Texas Instruments Inc.). US Patent 4,141,327. 27 Feb 1979. Filed date 9 Sep 1976. 8p.

The carburetion system for providing improved cold start engine operation comprises a carburetor having an air-fuel passage, an air inlet to the passage, a fuel inlet to the passage for mixing fuel and air in the passage, and an outlet from the passage for delivering a mixture of air and vaporized fuel to the engine. A heater comprising a ceramic resistor body of a material of positive temperature coefficient of resistivity has a plurality of passages extending through the body and has means directing electrical current through the body for heating the body. The heater is mounted at the outlet of the air-fuel passage of the carburetor with the heater body passages aligned with the air-fuel passage to pass the air-fuel mixture through the heater passages in heat-transfer relation to the body to facilitate vaporization and mixing of the fuel in the air-fuel mixture.

41183 **Closed loop control system for hydrogen fuelled engine.** Wolber, W.G. (to Bendix Corp.). US Patent 4,141,326. 27 Feb 1979. Filed date 11 Mar 1977. 18p.

Disclosed is a closed loop fuel control system for a hydrogen fuelled engine embodying a hydrogen sensor in the exhaust manifold to provide a feedback signal indicative of the quantity of unburned hydrogen in the engine's exhaust. The system electronically controls or trims the fuel delivery to the engine in response to signals indicative of the engine's operating parameters and the signal generated by the hydrogen sensor to maintain the concentration of hydrogen in the exhaust at a predetermined level.

41184 **Water vapor injection system.** Hart, R.H. US Patent 4,141,323. 27 Feb 1979. Filed date 11 Jan 1978. 12p.

The invention relates to a water vapor injection system for introducing artifically high humidity air into the carburetor of an internal combustion engine. Once delivered to the carburetor, the high humidity or moisture-laden air mixes with the air-fuel mixture normally passing from the carburetor into the combustion chambers to increase the combustion efficiency of the internal combustion engine. A forced air system is generated by an air injection pump, and this forced air is heated to alter its vaporization characteristics prior to being circulated through a water filled container. As the heated air is exposed to the water within the container, the air increases in moisture content as the heat associated with the air tends to vaporize water about the interface between respective bubbles and the surrounding water. Because of the continuous force of the pump, the high moisture air realized from passing the air through the water filled container is then forced from the container into the immediate area of the top of the carburetor.

SPARK-IGNITION

41185 **Mathematical modeling of combustion process in a spark-ignition engine.** Surakomol, K. Detroit, MI; Wayne State Univ. (1978). 172p. University Microfilms Order No. 79-08,968.

Thesis (Ph. D.).

One-dimensional unsteady analysis of turbulent flame propagation has been used to determine the heat release rate. This model considers the combustion chamber geometry, piston face profile and spark plug location. The chemical kinetic analysis has been used to predict the N0 emission level as a function of time and chamber position. Equilibrium calculation of C0 emission level at the end of combustion process has been performed. A computer program has been developed to solve the flame propagation and kinetic equations.

DIESEL

REFER ALSO TO CITATION(S) 41192

41186 **Design of integrated automobiles to meet societal goals.** Digges, D. (National Highway Traffic Safety Administration, Washington, DC). pp 389-396 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

NHTSA's Research Safety Vehicle (RSV) program is developing experimental automobiles to meet the combined and balanced

goals in safety, energy, the environment, and economy for the 1980's. The vehicles will integrate and harmonize advanced technology in safety, fuel economy, emissions, damageability, productibility, and maintainability; and the vehicles will provide economy of ownership. The program is being conducted in 4 phases and focuses on 4- and 5-passenger vehicles weighing less than 3000 pounds. Phase I, completed in May 1975, involved AMF, Ford, Calspan, Minicars, and Volkswagen. Phase II, completed in May 1977, involved Calspan of Buffalo and Minicars of Goleta, California. Volkswagen continued to participate in the Phase II program to assess technology advancements that could improve the fuel economy and emissions of engines suitable for the RSV size vehicles. Evaluation of a Volkswagen turbo-diesel vehicle is now underway. Further improvements in emissions and fuel economy are anticipated during Phase III. It includes final vehicle design and testing, integration of improved engines, and fabrication of approximately 17 vehicles by Calspan and Minicars for independent evaluation. This evaluation will include fuel economy, emissions, and performance tests as well as crash tests. Phase IV will begin in October 1978. It will consist of independent test and evaluation by the government of the Phase III vehicles. (MCW)

ELECTRIC-POWERED SYSTEMS

REFER ALSO TO CITATION(S) 41155

HYBRID SYSTEMS

REFER ALSO TO CITATION(S) 41000

VEHICLE DESIGN FACTORS

REFER ALSO TO CITATION(S) 41100

EMISSION CONTROL

REFER ALSO TO CITATION(S) 41180, 41185

41187 Catalytic converter for exhaust gases. Goedicke, E. (to Hoechst Aktiengesellschaft). US Patent 4,148,860. 10 Apr 1979. Priority date 9 Dec 1976, German, Federal Republic of (F.R. Germany), 8p.

The invention discloses a device for holding a granular catalyst suitable for use in the decontamination of exhaust gas from an internal combustion engine. The device comprises a housing which is closed by means of end plates and provided with a gas inlet and gas outlet and in which there is disposed a sleeve having perforated walls which are substantially circular in cross-section, this sleeve being disposed therein substantially concentrically with respect to the gas inlet. The device is provided with one or more flow-defining means which are accommodated in the housing, the gas flow-defining means causing gas admitted to the housing to be at least partially directed in a substantially axial direction so as to form a stream flowing under increased static pressure towards one of the end regions of the sleeve.

41188 Catalyst monolith for exhaust gas decontamination, preferably in motor vehicles. Abthoff, J.; Schuster, H.D. (to Daimler-Benz AG). US Patent 4,145,394. 20 Mar 1979. Priority date 16 Mar 1973, German, Federal Republic of (F.R. Germany), 6p.

The invention discloses a monolithic catalyst structure for purifying exhaust gases particularly in motor vehicles in which the monolithic catalyst is connected with tubularly shaped metallic support members by way of a sintered intermediate layer and in which the support members carry the monolithic catalyst inside of a tubularly shaped catalyst housing through which flow the exhaust gases.

41189 Exhaust gas purifying device of an internal combustion engine. Tokoro, M. (to Toyota Jidosha Kogyo Kabushiki Kaisha). US Patent 4,144,711. 20 Mar 1979. Priority date 7 Dec 1976, Japan, 6p.

Disclosed is an internal combustion engine comprising a catalytic converter containing a three way catalyzer. A secondary air feed control device, an air-fuel ratio detector, and the catalytic converter are arranged in this order in the exhaust passage of the engine. An exhaust gas mixing device is disposed in the exhaust passage between the air—fuel ratio detector and the catalytic converter so as to make a total air—fuel ratio in the inlet of the catalytic converter equal to the stoichiometric air—fuel ratio at all times.

41190 Oxygen sensor particularly useful in exhaust system of automotive engine. Kita, T.; Fujishiro, T. (to Nissan Motor Co., Ltd.). US Patent 4,141,813. 27 Feb 1979. Priority date 19 Feb 1976, Japan, 12p.

A solid electrolyte tube closed at one end and two porous electrode layers respectively coated on the outer and inner surfaces of the electrolyte tube constitute a known oxygen concentration cell. A tubular metal shell encloses the electrolyte tube partly such that a closed end portion of the tube protrudes from the shell and that the outer electrode coating is locally in contact with the inside of the shell. To protect the open end of the electrolyte tube against splashing of water during use without interrupting the admission of atmospheric air as a reference gas into the inside of the electrolyte tube, a tubular cap member of a metal is coaxially fixed to and electrically connected at its one end to the shell at one end portion surrounding the open end of the electrolyte tube, and a cross-sectionally circular plug of an insulating material is coaxially and tightly received in and fixed to the cap member to occupy an end portion, contiguous to the free end, of the interior of the cap member. This plug has two axial bores which respectively allow two cable wires of the sensor to tightly pass therethrough and an air-admitting passage formed therein independently of these two bores in such an arrangement and cross-sectional area that unpressurized water does not pass therethrough from the atmosphere to the unoccupied portion of the interior of the cap member.

ALTERNATIVE FUELS

REFER ALSO TO CITATION(S) 41183

41191 (HCP/M2752—01) Survey of liquid hydrogen container techniques for highway vehicle fuel system applications. Escher, W.J.D. (Escher Technology Associates, St. Johns, MI (USA)). Nov 1978. Contract EC-77-X-01-2752. 66p. Dep. NTIS, PC A04/MF A01.

A technology-oriented survey of several recent and ongoing development and demonstration projects involving liquid hydrogen containers for fuel-system service in highway transportation systems has been conducted. In addition to providing technical coverage of those involved research and development organizations in the United States and overseas (namely in Japan and the Federal Republic of Germany), projected production cost information provided by several U.S. cryogenic vessel manufacturers is included. Along with appropriate background review, two aspects of the subject are accordingly reported on: (1) design and operational features of four different liquid hydrogen container types, three of which have served operationally as vehicle fuel tanks, and (2) rough production-lot cost estimates for a nominal 50 gallon (189 liter) horizontal cylindrical liquid hydrogen container applicable to vehicle service. Also, a unique semiautomatic liquid hydrogen service station developed in Germany is described as a third aspect of this subject. A general assessment of the state of technology of vehicle hydrogen containers and associated systems is given, including the identification of pacing items recommended to be addressed initially in prospective R and D activities in this field.

41192 (PB—287386) Fundamental combustion studies of emulsified fuels for diesel applications. Final report, 1 July 1974—30 September 1977. Dryer, F.L.; Glassman, I. (Princeton Univ., NJ (USA). Guggenheim Labs. for the Aerospace Propulsion Sciences). Dec 1977. 233p. NTIS PC A11/MF A01.

Improved understanding of the combustion properties of emulsified water-fuel mixtures could lead to better energy utilization/emission characteristics for energy conversion systems which employ spray combustion. The combustion properties of emulsified fuels required for guiding optimization of practical applications were studied. The program's goal was to define the combustion characteristics of water-in-fuel emulsions and to experimentally investigate the relationships of emulsion characteristics at the micro-explosion phenomena. Interest in improving operating characteristics of light vehicle diesel power plants to levels acceptable for large scale integration into the private transportation sector originally motivated this program. Aspects of the program are also relevant to use in other combustion systems. Research encompassed emulsion formation techniques, physical characteristics, emulsion coalescence kinetics (stability), single suspended and free droplet combustion, spray characterization and nucleate vaporization (of the internal phase) prediction. Results have been used to critically evaluate published practical results, predict favorable applications for emulsion combustion, and guide full scale implementation research and development elsewhere. This final report summarizes the results and accomplishments of the program.

MATERIALS

41193 (PB—287013) **Properties of selected superconductive materials, 1978 supplement. Technical note.** Roberts, B.W. (General Electric Co., Schenectady, NY (USA). Superconductive Materials Data Center). Oct 1978. 103p. NTIS PC A06/MF A01.

This report includes data on additional superconductive materials extracted from the world literature up to fall 1977 and is an addendum to the data set published in J. Phys. Chem. Ref. Data 5, no. 3, 581-821 (1976) (Reprint no. 84). The data presented are new values and have not been selected or compared to values (except for selected values of the elements) previously assembled by the Superconductive Materials Data Center. The properties included are composition, critical temperature, critical magnetic field, crystal structure and the results of negative experiments. Special tabulations of high magnetic field materials with Type II behavior and materials with organic components are included. All entries are keyed to the literature. A list of recent reviews centered on superconductive materials is included.

41194 **Rare earths in modern science and technology.** McCarthy, G.J.; Rhyne, J.J. (eds.). New York, NY; Plenum Press (1978). 643p. (CONF-771039—).

From 13. rare earth research conference; Olgebay Park, WV, USA (16 Oct 1977).

Separate abstracts were prepared for items in scope for the data base. (FS)

METALS AND ALLOYS

41195 (NUREG/CR—0656) **Heavy-Section Steel Technology Program. Quarterly progress report, October—December 1978.** Whitman, G.D.; Bryan, R.H. (Oak Ridge National Lab., TN (USA)). 8 Mar 1978. Contract W-7405-ENG-26. 72p. (ORNL/NUREG/TM—298). Dep. NTIS, PC A04/MF A01.

Progress is reported concerning theoretical solid state physics, surface and near-surface properties of solids, defects in solids, transport properties of solids, neutron scattering, crystal growth and characterization, and isotope research materials. Data are also reported on publications and papers, seminars, scientific professional activities, personnel changes, and programmatic manpower distributions. (FS)

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 40831, 41225, 41229, 41541, 41542

41196 (BDX—613-2114) **Feasibility of electroplated gold for hybrid microcircuits.** Blessner, P.L. (Bendix Corp., Kansas City, MO (USA)). 1978. Contract AC04-76DP00613. 27p. Dep. NTIS, PC A03/MF A01.

Electroplating was investigated as a method of providing thick gold films. Because electroplated gold has never been used for hybrid microcircuit (HMC) substrate metallization, this feasibility study was also designed to determine the characteristics of electroplated gold and its compatibility with present HMC fabrication processes. Ceramic substrates 95 by 114 mm (3.75 by 4.5 in.) were electroplated with 6, 10, and 25 μm of gold after 0.02 μm of chromium and 0.5 μm of gold had been either sputtered or vacuum evaporated onto the substrate surfaces. Substrates vacuum evaporated with 6 μm of gold were used as a control group. The substrates were evaluated for via resistance, RF electrical characteristics, conductor definition and resolution, solder wettability, thermocompression bondability, and environmental stability.

41197 (BDX—613-2133) **Chemical characterization of a mixed (orthophosphoric/polyphosphoric) acid aluminum etchant.** Win, H.; Morin, T.J. (Bendix Corp., Kansas City, MO (USA)). Jan 1979. Contract EY-76-C-04-0613. 29p. (CONF-790618—1). Dep. NTIS, PC A03/MF A01.

From 66. annual AES conference and exhibit of industrial finishing; Atlanta, GA, USA (24 Jun 1979).

Sensitivity of an orthophosphoric acid, a polyphosphoric acid, and an iron (III) chloride etchant to variations in process conditions was examined to determine the potential production application of the etchant system in the photolithographic fabrication of pure aluminum circuits. The effects of changes in temperature, orthophosphoric acid concentration, polyphosphoric acid concentration, iron (III) chloride concentration, and dissolved aluminum concentration on etched circuit quality and etch rate were examined. The etchant system allows reasonable variation in preparation and circuit processing without drastically affecting the etched circuit quality. Control of the etchant can be maintained over a broad range of temperatures and compositions.

41198 (LA—7702-C(Del.)) **Interagency mechanical operations group subgroup on joining. Minutes of twenty-second meeting, October 17—18, 1978.** Brandon, E. (comp.). (Los Alamos Scientific Lab., NM (USA)). Mar 1979. Contract W-7405-ENG-36. 51p. (CONF-7810171—). Dep. NTIS, PC A04/MF A01.

From 22. meeting of the IMOG; Kansas City, KS, USA (17 Oct 1978).

Subjects discussed on joining included beryllium joining, electron beam braze welding of beryllium, welding of reduced residual radiation devices, solid state bonding fracture toughness of steel-to-aluminium deformation welds, high strength Nitronic 33 stainless steel weldments, reservoir fabrication by resistance welding, electron beam welding machine upgrading for advanced tactical weapons, highly defocussed electron beam welding of aluminium, and W-79 weld development update. A report was made on the August 1978 Henniker conference on welding R and D. (FS)

41199 **Ion implantation in semiconductors, 1976.** Chernow, F.; Borders, J.A.; Brice, D.K. (eds.). New York, NY; Plenum Press (1977). 766p. (CONF-760836—).

From Proceedings of V international conference on ion implantation in semiconductors and other materials; Boulder, CO, USA (9 Aug 1976).

Separate abstracts have been prepared for items within the scope of the energy data base. (FS)

41200 (UCRL—13989) **Development and initial characterization of amorphous metals rich in W and/or RE.** Giessen, B.C.; Polk, D.E. (Northeastern Univ., Boston, MA (USA)). 1978. Contract W-7405-ENG-48. 58p. Dep. NTIS, PC A04/MF A01.

Portions of this document are illegible.

Studies of refractory metal alloys concentrated on two families of such alloys: ternary tungsten alloys and binary T_s-T_9 alloys. The former were selected because of the possibility of finding desirable glasses consisting of low-cost components; the latter were chosen because they could be quenched into metallic glasses with high thermal stability and good toughness. Alloys selected for study were prepared by arc-melting and were subsequently rapidly quenched in an arc furnace quenching unit. Considerable difficulties were encountered in preparing metal—metalloid alloys, such as W—B, as well as alloys combining high melting and low melting transition metals, such as W and Ni. Brittleness of ductility as revealed by a bend test was noted. Measurements were made up to 1000 K and resistivity measurements up to 1300 K. The probe for electrical resistivity measurements at high temperatures has been constructed and tested. To determine the elastic (Young's) moduli of new metallic glasses prepared in this program, equipment utilizing the pulse—echo method was set up.

41201 **Copper-base alloy for liquid phase sintering of ferrous powders.** Wang, J.L.; Pickus, M.R.; Chen, M.H. (to Dept. of Energy). US Patent 4,130,422. 19 Dec 1978. Filed date 16 Jun 1977. 6p.

PAT-APPL-807,106.

A copper-base alloy composition consisting of 85 to 89% copper, 2 to 4% manganese, and 8 to 11% silicon is described. Use in liquid phase sintering of ferrous powders is explained.

41202 **Gamma prime hardened nickel—iron based superalloy.** Korenko, M.K. (to Dept. of Energy). US Patent 4,129,462. 12 Dec 1978. Filed date 7 Apr 1977. 8p.

PAT-APPL-785,640.

A low swelling, gamma prime hardened nickel—iron base superalloy useful for fast reactor duct and cladding applications is described having from about 7.0 to about 10.5 weight percent (wt%) chromium, from about 24 to about 35 wt% nickel, from about 1.7 to 2.5 wt% titanium, from about 0.3 to about 1.0 wt% aluminum, from about 2.0 to about 3.3 wt% molybdenum, from about 0.05 to about 1.0 wt% silicon, from about 0.03 to about 0.06 wt% carbon, a maximum of about 2 wt% manganese, and the balance iron.

41203 **Polycrystalline silicon semiconducting material by nuclear transmutation doping.** Cleland, J.W.; Westbrook, R.D.; Wood, R.F.; Young, R.T. (to Dept. of Energy). US Patent 4,129,463. 12 Dec 1978. Filed date 29 Jun 1977. 10p.

PAT-APPL-811,348.

A NTD semiconductor material comprising polycrystalline silicon having a mean grain size less than 1000 microns. Phosphorus is dispersed uniformly throughout the silicon rather than at the grain boundaries.

41204 **Single crystals of rare earth metals, alloys and intermetallic compounds.** McMasters, O.D.; Beaudry, B.J.; Gschneider, K.A. Jr. (Iowa State University, Ames). pp 323 of Rare earths in modern science and technology. McCarthy, G.J.; Rhyne, J.J. (eds.). New York, NY; Plenum Press (1978).

From 13. rare earth research conference; Olgebay Park, WV, USA (16 Oct 1977).

Large single crystals of Sc, Y, Gd, Tb, Dy, Ho, Er, and Lu have been grown by the recrystallization method. Also large crystals of Nd and Pr have been prepared using a floating zone technique. Crystals of intra rare earth alloys, such as Ce in Y and Nd in Pr, have been obtained by both techniques. Single crystals of congruently and incongruently melting intermetallic compounds have resulted from the floating zone and Bridgman techniques. These include some RFe_2 Laves phases and La_2S_3. Analyses of the crystals and growth conditions will be presented. Several crystals will be on display.

41205 Ion nitriding of titanium and zirconium by a dc-glow discharge method. Liu, M.B.; Gruen, D.M.; Krauss, A.R.; Reis, A.H. Jr.; Peterson, S.W. (Argonne National Lab., IL). *High Temp. Sci.;* 10: 53-65(1978).

Nitrided surfaces of titanium and zirconium were prepared by operating a dc-glow discharge in a mixture of 20% N_2 and 80% H_2 at 20 to 40 Torr. The discharge was confined between a stainless steel anode and the sample at about 500 mA with a dc potential of 360 to 400 V. The temperature of the sample was about 900°C. The kinetics of metal nitride formation are enhanced by about a factor of three in the dc discharge technique compared with either rf discharge or thermal nitriding methods. The golden-yellow nitrided surfaces were characterized by energy-dispersive x-ray and electron diffraction techniques. The results show that the nitrided surfaces contain mononitride phases. Depth-profile measurements were performed by argon-ion etching and surface analysis by means of XPS. The kinetics of the formation of surface nitride layers are discussed in terms of a reaction involving nitrogen—hydrogen molecular ions with the substrate. Diffusion of nitrogen into the bulk determines the rate of growth of the nitride layer.

41206 Metallurgical applications of ion implantation. Myers, S.M. (Sandia Labs., Albuquerque, NM). pp 167-177 of Ion implantation in semiconductors, 1976. Chernow, F.; Borders, J.A.; Brice, D.K. (eds.). New York, NY; Plenum Press (1977).

From Proceedings of V international conference on ion implantation in semiconductors and other materials; Boulder, CO, USA (9 Aug 1976).

Ion implantation can be used to produce atomic mixtures of controlled composition, independent of thermodynamic constraints, and to introduce lattice damage at rates exceeding 1 dpa/sec. These unique capabilities are being exploited for the study of intermetallic alloys in two different temperature regimes. At lower temperatures, where atomic mobilities are nil, the technique is being used to investigate new metastable phases. These have included substitutional solid solutions of immiscible elements, amorphous alloys, and improved superconductors of nonequilibrium compositions. At higher temperatures, where appreciable atomic diffusion occurs over experimental times, implantation is being employed to study equilibrium alloys. Previously unavailable information about phase diagrams and diffusion rates has been obtained at much lower temperatures and in complex alloy systems.

41207 Solubility enhancement in ion implanted Cu alloys. Poate, J.M. (Bell Laboratories, Murray Hill, NJ); Borders, J.A.; Cullis, A.G.; Hirvonen, J.K. pp 179-180 of Ion implantation in semiconductors, 1976. Chernow, F.; Borders, J.A.; Brice, D.K. (eds.). New York, NY; Plenum Press (1977).

From Proceedings of V international conference on ion implantation in semiconductors and other materials; Boulder, CO, USA (9 Aug 1976).

Measurements on high-dose implants of Ag in Cu are reported. Although the maximum reported solubility of Ag in Cu is 0.1 at. % at 200°C, we have observed complete substitutionality for 10 at. % Ag implants in Cu at room temperature. This is an intriguing result as complete solid solutions of Ag and Cu would indeed be expected from simple size and electronegativity arguments. These results will be correlated with previously reported measurements on splat-cooled samples where non-equilibrium alloys were obtained.

41208 AlSb precipitate evolution during Sb implantation in Al: experiment and theory. Kant, R.A. (Univ. of New Mexico, Albuquerque); Myers, S.M.; Picraux, S.T. pp 191-200 of Ion implantation in semiconductors, 1976. Chernow, F.; Borders, J.A.; Brice, D.K. (eds.). New York, NY; Plenum Press (1977).

From Proceedings of V international conference on ion implantation in semiconductors and other materials; Boulder, CO, USA (9 Aug 1976).

Precipitate evolution during ion implantation has been studied in the model system Sb-implanted Al. Transmission electron microscopy was used to determine the size distribution of AlSb crystallites as a function of fluence, flux, and sample temperature. There was a dramatic increase in average size, accompanied by a decrease in number density, for increasing fluence, for decreasing flux, and for increasing temperature. A new theoretical model for the evolution of the precipitate size distribution has been developed which incorporates both thermal processes and implantation effects. Numerical solutions for the AlSb system using physically realistic parameters agree qualitatively with the experimentally observed evolutions.

41209 Dechanneling by dislocations in Zn-implanted Al. Foti, G.; Picraux, S.T.; Campisano, S.U.; Rimini, E.; Kant, R.A. (Instituto di Struttura della Materia, Catania, Italy). pp 247-255 of Ion implantation in semiconductors, 1976. Chernow, F.; Borders, J.A.; Brice, D.K. (eds.). New York, NY; Plenum Press (1977).

From Proceedings of V international conference on ion implantation in semiconductors and other materials; Boulder, CO, USA (9 Aug 1976).

The influence of dislocations on the dechanneling of energetic channeled ions has been investigated. Channeling effect and transmission electron microscopy (TEM) techniques were used to measure the disorder in 1.2 to 2.6 x 10^{16}/cm^2 Zn-implanted Al crystals. Channeling analysis along the <110> axis was made with He beam energies ranging between 1.0 and 3.0 MeV. From TEM measurements, a dense network of dislocations is found to be the predominant type of defect in the implanted layer. From our analysis of the energy dependence of the dechanneling, together with the TEM determination of the total projected dislocation length, we obtain the first experimental measurement by backscattering of the dechanneling cross section, λ, for a dislocation. The experimental value, λ(A) = 20[E(MeV)]/sup 1/2/, agrees closely in magnitude and in energy dependence with theoretical prediction. From these studies, we estimate that the minimum dislocation density for detection by channeling is 10^9 to 10^{10} cm length of line/cm^3.

41210 Formation of highly-doped thin layers by using knock-on effect. Ishiwara, H.; Furukawa, S. (Tokyo Inst. of Technology, Japan). pp 375-382 of Ion implantation in semiconductors, 1976. Chernow, F.; Borders, J.A.; Brice, D.K. (eds.). New York, NY; Plenum Press (1977).

From Proceedings of V international conference on ion implantation in semiconductors and other materials; Boulder, CO, USA (9 Aug 1976).

Optimum conditions in the recoil implantation to form highly-doped thin layers on the semiconductor surfaces have been discussed by using He and N ions backscattering techniques and electrical measurements. A thin n-type layer with sheet resistivity of 300 Ω/dal was obtained on a p-type Si wafer by implantation of 100 keV Si ions through an As film at a dose of 3 x 10^{14} cm^{-2}. In case of an Sb film the sheet resistivity was about 10 times higher than that in the As film.

41211 Ion implanted solar cells. Neilson, J.B.; Vanderwel, T.M.; Shewchun, J.; Thompson, D.A. (McMaster Univ., Hamilton, Ontario). pp 543-553 of Ion implantation in semiconductors, 1976. Chernow, F.; Borders, J.A.; Brice, D.K. (eds.). New York, NY; Plenum Press (1977).

From Proceedings of V international conference on ion implantation in semiconductors and other materials; Boulder, CO, USA (9 Aug 1976).

Ion implantation is investigated as a technique to fabricate solar cells on monocrystalline silicon. The effects of implanted species (As and P), implanted dopant concentration (10^{18} to 10^{21} Cm^{-3}), implant temperature (55° to 300°K) and annealing temperature (700° to 900°C) have been studied. Some progress has been made toward optimization of the various parameters.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 40831, 41206, 41207, 41224, 41262, 41265, 41978

41212 (BNL—25917) **Neutron scattering study of premartensitic phases of TiNi(Fe).** Salamon, M.B.; Meichle, M.; Wayman, C.M.; Hwang, C.M.; Shapiro, S.M. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 4p. (CONF-790341—6). Dep. NTIS, PC A02/MF A01.

From International conference on modulated structures; Kailua-Kona, HI, USA (22 Mar 1979).

The premartensitic phases of TiNi(Fe) have been studied by means of neutron diffraction, specific heat, and electron microscopy. Evidence for an incommensurate charge density wave has been found, with a wavevector near, but not at, (h/3, k/3, 0) positions. A lock-in transition occurs at lower temperatures, accompanied by the formation of needle-shaped domains oriented along [110] directions.

41213 Communications: on the orientation relationships between retained austenite and lath martensite. Narasimha Rao, B.V. (Univ. of California, Berkeley). *Metall. Trans., A;* 10A: No. 5, 645-651(May 1979).

The orientation relationships between retained austenite and lath marteniste transformation are reported. Direct crystallographic analysis using retained austenite ceveals that the dominant austenite-martensite (lath) orientation relation in medium carbon experimental

steels corresponds to either Kurdjumov-Sachs (K-S) or Nishiyama-Wasserman (N-W) relationships depending on the composition.

41214 Superconductivity in Nb_5Si_3. Willis, J.O.; Waterstrat, R.M. (Naval Research Laboratory, Washington, D.C. 20375). *J. Appl. Phys.;* **50**: No. 4, 2863-2866(Apr 1979).

A sample of the high-temperature (β) phase of Nb_5Si_3, possessing the tetragonal W_5Si_3 structure, had a superconducting transition temperature T_0 of 0.7 K and a transition width of about 0.25 K. The value of -67 mT/K (670 Oe/K) for the initial slope of the curve of the critical magnetic field versus temperature indicates that β-Nb_5Si_3 is a type-II superconductor. The dominant structural feature of β-Nb_5Si_3 is the parallel linear chains of closely spaced Nb atoms which occur along the tetragonal c axis. The Nb-Nb intrachain spacing is 0.254 nm, very close to the Nb-Nb spacing of the mutually orthogonal linear chain atoms in a hypothetical cubic A15-Nb_3Si structure. The near-neighbor environment of the Nb chain atoms is virtually identical in A15-Nb_3Si and β-Nb_5Si_3. However, the T_0 of A15-Nb_3Si is expected to be greater than 20 K, much higher than the T_0 of β-Nb_5Si_3. The presence of closely spaced Nb atoms in linear chains therefore does not appear to be a sufficient condition for a high T_0. The low-temperature (α) phase of Nb_5Si_3 was found to be normal down to 0.01 K.

41215 NMR of Cu satellites in the Kondo alloy CuCr. Azevedo, L.J.; Follstaedt, D.; Narath, A. (Sandia Laboratories, Albuquerque, New Mexico 87185). *J. Appl. Phys.;* **50**: No. B3, 1746-1748(1 Mar 1979).

Using pulsed NMR techniques, resonances of Cu nuclei which are near neighbors to Cr impurities (c=100 and 200 ppm) in CuCr (θ/sub k/~3 K) have been studied in the temperature range 1—4 K and applied fields H/sub o/=20—125 kOe. At the highest fields and lowest temperatures the satellite shifts approach saturation. Above ~40 kOe the spin-lattice relaxation rate T_1^{-1} is proportional to T/H/sub o/^{2}, indicating that the dominant relaxation mechanism arises from transverse fluctuations of a polarized local moment. The measured rates yield a local-moment/conduction-electron exhange interaction vertical-barJrhovertical-bar/g=0.30, where g is the Cr g-value. Below ~40 kOe T_1^{-1} appears to be slightly enhanced in comparison with the high-field behavior, but becomes field independent below ~30 kOe. Both effects are attributed to Kondo anomalies.

41216 Structure of $CoZrD_3$. Irodova, A.V.; Somenkov, V.A.; Shil'shtein, S.S.; Padurets, L.N.; Chertkov, A.A. *Sov. Phys. - Crystallogr. (Engl. Transl.);* **23**: No. 5, 591-592(Sep 1978).

The crystal structures of CoZr and $CoZrD_3$ were studied by x-ray and neutron diffraction at room temperature and at 300°C.

41217 Intermetallic compounds as catalysts for hydrogenation of carbon oxides. Elattar, A.; Wallace, W.E.; Craig, R.S. (Univ. of Pittsburgh, PA). pp 87-92 of Rare earths in modern science and technology. McCarthy, G.J.; Rhyne, J.J. (eds.). New York, NY; Plenum Press (1978).

From 13. rare earth research conference; Olgebay Park, WV, USA (16 Oct 1977).

Two Fe-containing intermetallics ($CeFe_3$ and $ThFe_3$) and a series of intermetallic compounds of the type RM_2, where R is a rare earth or Th and M is Mn, have been studied as catalysts for the reaction of CO and CO_2 with H_2. The operation was carried out over a fixed bed powder catalyst at atmospheric pressure. The catalyst was examined by x-ray diffraction before and after the reaction. During the hydrogenation process the transition metal component of the intermetallic is essentially transformed into manganese oxide, while the rare earth or the actinide component is transformed into oxide. Certain intermetallics show higher activity than others. The product distribution depends upon the rare earth or actinide as well as upon the transition metal.

41218 Relative energies of simple metallic structures. Krause, C.W.; Morris, J.W. Jr. (Univ. of California, Berkeley). *Acta Metall.;* **22**: 767-777(Jun 1974).

The asymptotic form of the two-body interatomic potentials arising from pseudopotential theory, $V(r) = V_0\cos(2k/\text{sub } F/r)/(2k/\text{sub } F/r)^3$, is used to discuss the relative cohesive energies of simple metallic structures. Use of this potential allows the thermodynamically preferred structure of a simple metallic element or solid solution at 0K to be determined as a function of valence only. The appropriate lattice sums are performed exactly for the fcc, hcp (with ideal axial ratio) and bcc structures. In addition, the approximate interplanar interaction of Blandin et al. is summed for polytypic structures. Two modifications of the potential are also considered. First, a phase shift of 2δ is used to obtain a potential of the form, $V(r) = V_0\cos(2k/\text{sub } F/r + 2\delta)/(2k/\text{sub } F/r)^3$. Secondly, the interplanar interaction is adjusted to reflect conditions that might hold when polytypic structures other than fcc and hcp occur. Results for the relative energies of the structures are presented. These results are compared with the observed structures of metallic elements and random solid solutions.

41219 Characterization of metal-oxide tunnel-junction barriers. McBride, D. (Univ. of California, Berkeley); Rochlin, G.; Hansma, P. *J. Appl. Phys.;* **45**: No. 5, 2305-2312(May 1974).

A technique has been developed for determining unambiguously the effective barrier height phi and the average effective thickness S of the insulating layer in a metal-insulator-metal tunnel junction. The quantity S phi/sup 3/2/ is measured from the slope of the Fowler—Nordheim plot. The experimental data are then compared with a family of calculated current-voltage curves by using various pairs of S and phi with S phi/sup 3/2/ fixed at the measured value, in order to determine the pair which gives the best fit. The method has been tested on the best understood tunnel barrier, those grown thermally on an Al film, and is found to give good agreement with independent measurements. From a macroscopic viewpoint, the tunnel barrier seems adequately described by a trapezoidal barrier model of nearly uniform height but with thickness variations on a microscopic scale over the junction area. The use of the method is illustrated on barriers grown thermally on Cr, thin-film V, and bulk V. We present a series of graphs at varying S and phi for six different values of S phi/sup 3/2/ to facilitate the determination of approximate barrier parameters with lengthy computer calculations.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 40072, 40088, 40829, 40850, 40855, 40881, 40957, 41202

41220 (CONF-770807—Pt.L, pp vp) **Localization of plastic work at voids and inclusions in ductile fracture.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

41221 (CONF-770807—Pt.L, pp vp) **Experimental and theoretical investigation of creep buckling.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The purpose of the present paper is to investigate creep buckling phenomena and the methods of analysis. Creep buckling experiments were performed on aluminum alloy 2024-T4 cylindrical shells having radius to thickness ratios of 16, 25, 50 and 80, in single, double and triple step axial compression at 250°C. It was observed that buckling occurred at one of the edges and the buckling mode depended on the radius to thickness ratio and also on the applied stress level. Thicker cylinders buckled in axisymmetric mode. Thinner ones under higher applied stress levels buckled in the asymmetric mode, whereas they under lower applied stress levels buckled in the axisymmetric mode. Creep buckling times were obtained from end shortening record of the cylinders. Experimental results were compared with theoretical values obtained by the following two methods. One is a simplified method to estimate buckling times, proposed by Gerard et al., Papirno et al. and others. The method is based on the fact that the creep buckling solutions are analogous to those of plastic buckling under a certain assumption. It was found that the bukling times could be reasonably estimated by this simplified method. The other is a finite element computer program for axisymmetric thin shells. This program is based on the incremental theory and can treat thermoelastoplastic creep analysis of axisymmetric thin shells with large deflection. Creep deformation behavior of cylindrical shells under axial compression and buckling times were calculated by the program and the effects of plasticity on buckling times were also investigated.

41222 (CONF-770807—Pt.L, pp vp) **Constitutive equation for creep fracture under constant, variable or cyclic positive stress.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The present paper deals with the development and application of a constitutive equation for creep fracture of RR58 Aluminium alloy at 180°C under variable stress and such a constitutive equation can be extrapolated to cover long-time behavior just as with conventional constant stress creep fracture equations. Constant stress, in fact, is one of the boundary conditions of the general constitutive equation, representing zero prior damage. The other boundary condition is that of 'cadence loading' in which the stress is completely removed and then re-applied in a cyclic fashion. An exploratory paper (SMiRT-3 Paper L3/4) had shown that an important factor affecting residual life was the stage of creep at which a stress change took place. Accordingly, in the present work, stress changes were arranged to take place approximately at two stages during primary creep, one stage corresponding to minimum creep rate and one stage

is established tertiary creep. The creep fracture curve for virgin materials was also available, thus giving five levels of damage. A datum stress level was selected and specimens were damaged to each of the above stages of creep, whereupon the stress was changed and the residual life, at a series of new stress levels, determined. Additionally, a few other tests were carried out with initial stress levels other than the datum stress, in order to check the invariance of the damage with respect to the initial stress. Correlation and regression analyses of the results from 32 tests gave an exponential equation, the constants being dependent upon the degree of damage.

41223 (CONF-770807—Pt.L, pp vp) **Mechanical equation of state analysis of elevated temperature cyclic deformation of austenitic stainless steels.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The present work considers load relaxation data reported by Conway, Stentz and Berling, for 304 and 316 stainless steels during cyclic deformation with various hold times. The experiments were conducted at 650 and 538°C, temperatures sufficiently high so that recovery is likely to occur during the experiment. The experimental data are analyzed to determine if a power law suggested as an equation of state can represent the observed behavior. In 304 at 650°C short hold times and large cyclic strain amplitudes inhibit recovery. Conversely, long hold times and small cyclic strains promote recovery. At 538°C for 304 no evidence of recovery was found. Likewise in 316 at 650°C no recovery was found. These observations can be explained on the basis of thermal and strain induced recovery of the microstructure developed by cyclic deformation. When recovery occurs, stress relaxation no longer prescribes the loci of rate dependent behavior at a constant state; rather the material passes through a continuous succession of states. The results of this analysis indicate that the power law may provide an equation of states for the stainless steels.

41224 (CONF-770807—Pt.L, pp vp) **Microstructure and low-cycle fatigue behavior of inconel 718.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

41225 (RFP—2692) **Summary of mechanical properties for JBK-75 forgings.** Page, R.L.; Krenzer, R.W. (Atomics International Div., Golden, CO (USA). Rocky Flats Plant). 22 Mar 1979. Contract AC04-76DP03533. 22p. Dep. NTIS, PC A02/MF A01.

Increased strengths can be achieved in precipitation-hardened stainless steels by deforming the steel and retaining a worked structure prior to aging. JBK-75 is one example of a superalloy which will respond to this type of thermomechanical processing. The present study was undertaken to determine the tensile properties of different forged shapes resulting from the combined effects of strain hardening and precipitation hardening. Various size bar stock was deformed by High Energy Rate Forging (HERF) and subsequently aged. Resultant tensile properties were quite variable, showing a wide range of strengths and ductilities, well below expected values. The tensile properties were strongly dependent upon forging geometry.

41226 (UCB/EERC—79/09) **Design of steel energy absorbing restrainers and their incorporation into nuclear power plants for enhanced safety. Volume 3. Evaluation of commercial steels.** Owen, W.S.; Pelloux, R.M.N.; Ritchie, R.O.; Faral, M.; Ohhashi, T.; Toplosky, J.; Hartman, S.J.; Zackay, V.F.; Parker, E.R. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Materials Science and Engineering; California Univ., Berkeley (USA). Earthquake Engineering Research Center). Feb 1979. Contract EY-76-S-03-0034-269. 69p. Dep. NTIS, PC A04/MF A01.

The low cycle fatigue characteristics of types 301 and 303 stainless steels, Hadfield manganese steel, and 300-M were determined. In relation to the performance of a solid state damping device, Hadfield manganese steel appeared to be most desirable due to high energy absorption, good fatigue lifetime, and low temperature sensitivity. The changes in mechanical properties accompanying the metastable austenite transformation have imposed serious limitations on the operating environment of transforming steel devices. A machine capable of consistently producing pure shear in torsion bars was designed. Torsional low-cycle fatigue characteristics of commercial steels were examined and compared to empirically-based predictions. Empirical correlations between fatigue life, strain range, and energy absorption were developed.

41227 (UCID—18070) **Computer model for ductile fracture.** Moran, B.; Reaugh, J. E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 May 1979. Contract W-7405-ENG-48. 24p. Dep. NTIS, PC A02/MF A01.

A computer model is described for predicting ductile fracture initiation and propagation. The computer fracture model is calibrated by simple and notched round-bar tension tests and a precracked compact tension test. The model is used to predict fracture initiation and propagation in a Charpy specimen and compare the results with experiments. The calibrated model provides a correlation between Charpy V-notch (CVN) fracture energy and any measure of fracture toughness, such as J/sub Ic/. A second simpler empirical correlation was obtained using the energy to initiate fracture in the Charpy specimen rather than total energy CVN, and compared the results with the empirical correlation of Rolfe and Novak.

41228 **Failure analysis in coal conversion systems.** King, R.T. (Oak Ridge National Lab., TN). *SAMPE Q.;* 10: No. 3, 7-11(Apr 1979).

Analyses of material failures in pilot plants for coal conversion to alternate fuels and advanced coal combustors is in progress. Examinations of parts from the main reaction vessel area involving the highest pressures and temperatures of coal liquefaction plant are described. The probable cause of cracking of the air distributor plate of an atmospheric fluidized bed combustion boiler is identified.

41229 **Improvement of cryogenic mechanical properties of Fe-12 Mn and Fe-8 Mn alloy steels through thermal/mechanical treatments.** Hwang, S.K.; Morris, J.W. Jr. (Univ. of California, Berkely). *Metall. Trans., A;* 10A: No. 5, 545-555(May 1979).

An ivestigation has been made to improve the low temperature mechanical properties of Fe-8Mn and Fe-12Mn-0.2 Ti alloy steels. A reversion annealing heat treatment in the two-phase ($\alpha + \gamma$) region following cold working has been identified as an effective treatment. In an Fe-12Mn-0.2Ti alloy a promising combination of low temperature (-196°C) fracture toughness and yield strength was obtained by this method. The improvement of properties was attributed to the refinement of grain size and to the introducion of a uniform distribution of retained austenite (γ). It was also shown that an Fe-8Mn steel could be grain-refined by a purely thermal treatment because of its dislocated α' martensitic structure and absence of ϵ martensite. As a result, a significant reduction of ductile to brittle transition temperature was obtained.

41230 **Deformation of Pb—Sn eutectic alloys at relatively high strain rates.** Grivas, D.; Murty, K.L.; Morris, J.W. Jr. (Univ. of California, Berkeley). *Acta Metall.;* 27: No. 5, 731-737(May 1979).

The steady-state stresses of lead—tin eutectic alloy (Pb—62Sn) samples of mean phase diameter from 5.5 to 9.9 μm were measured over a range of temperatures from 0° to 160°C and strain rates from 2.66×10^{-5} to $1.33 \times 10^{-2} s^{-1}$. The alloy exhibited both conventional and superplastic deformation over this range of experimental variables. The data were consistent with the assumption that the two deformation behaviors occur simultaneously via independent mechanisms. The data may be repesented by the dimensionless constitutive relation $\gamma = 900(\tau\mu^*)^{1.96} (d^*)^{-1.8} \exp(-11{,}500/RT) + (1.3 \times 10^{15})(\tau\mu^*)^{7.1} \exp(-19{,}400/RT)$, where the first term on the right gives the rate of superplastic deformation and the second term gives the rate of conventional deformation.

41231 **Grain boundary and interphase boundary sliding in power law creep.** Chen, I.W.; Argon, A.S. (Massachusetts Inst. of Tech., Cambridge). EG-77-S-02-4461. *Acta Metall.;* 27: No. 5, 749-761(May 1979).

The self-consistent theory for polycrystals and composites can be extended readily to consider the effect of grain boundary sliding where the sliding boundaries are treated as disk-shaped viscous heterogeneities of a critical volume fraction to result in contiguously connected boundary paths through the material. The approach leads to particularly simple visualizable effects of strain rate enhancement in creeping polycrystals with sliding boundaries and to readily obtainable asymptotic limiting behavior for completely relaxed boundaries over a certain range of strain rate sensitivity of the grain matrix. Finally, this approach can also be combined with a self-consistent model for creep in a heterogeneous alloy to determine the behavior of creeping composite alloys with sliding grain boundaries and entrapped interphase boundaries.

41232 **Elastic interaction of defect clusters with arbitrary strain fields in an anisotropic continuum.** Yamauchi, H.; De Fontaine, D. (Univ. of California, Los Angeles). *Acta Metall.;* 27: No. 5, 763-776(May 1979).

Fourier transform techniques applied to anisotropic linear continuum elasticity theory are used to calculate interaction energies between pairs of defect clusters, the defects being characterized by distortion tensors of arbitrary symmetry. Far-field interaction energies are expressed by means of a single integration over a closed form angle-dependent function. Near-field interactions are evaluated by numerical integration for the case of spherical defect clusters. For isotropic distortion centers in a Cu matrix, interaction energy minima are formed along the [100] directions at separations just greater than the touching distance of the spheres, therby leading to a simple cubic

array of precipitates, as is encountered in the Ni-base superalloys, for example. The depth, position and orientation of the interaction energy minimum change as the symmetry of the defect distortion tensor is altered. A Fourier method is also developed for calculating the self-energy of a defect cluster which gives excellent agreement with the self-energy calculated by a direct-space method.

41233 Steady state power-law creep in heterogeneous alloys with coarse microstructures. Chen, I.W.; Argon, A.S. (Massachusetts Inst. of Tech., Cambridge). EG-77-S-02-4461. *Acta Metall.;* **27**: No. 5, 785-797(May 1979).

In many heterogeneous engineering alloys of a relatively coarse phase distribution where non-local effects due to such phases are unimportant and where inelastic deformation inside these phase domains can be appropriately viewed by continuum concepts, the overall steady creep behavior of the alloy can be obtained by the use of the well-known self-consistent theory for polycrystals and composites, in a piece-wise linear and incremental approach—provided the creep constitutive behavior for each of the constituent phases is known.

41234 Efficiency of vacancy annihilation at a surface and at dislocation loops in quenched aluminum. Lam, N.Q.; Hoff, H.A.; Okamoto, P.R.; Siegel, R.W. (Argonne National Lab., IL). *Acta Metall.;* **27**: No. 5, 799-805(May 1979).

The average efficiencies of dislocation loops and the surface as sinks for supersaturated vacancies in quenched aluminum at 40°C were measured using stereo electron microscopy. The growth of dislocation loops in the region adjacent to the surface was used to investigate the competition between the surface and the growing dislocation loops for the annihilation of vacancies. Comparing the spatial dependence of the fully grown loop size with the solution of the appropriate diffusion equation, the average efficiencies of both types of sinks were determined. The values of the efficiencies are anti ϵ/sub L/ = 0.9 +- 0.1 and anti ϵ/sub S/ = 0.7 +- 0.1 for dislocation loops and the surface, respectively. The results indicate that dislocation loops are quite good sinks during their growth at 40°C and that the aluminum surface, which is always covered by a protective and adhesive oxide layer, is not a perfect sink for vacancy annihilaton.

41235 Rise-time measurements of shock transitions in aluminum, copper, and steel. Chhabildas, L.C.; Asay, J.R. (Sandia Laboratories, Albuquerque, New Mexico 87185). *J. Appl. Phys.;* **50**: No. 4, 2749-2756(Apr 1979).

Time-resolved measurements of shock-wave rise times have been accomplished for aluminum, copper, and steel to stress levels of 41, 96, and 139 GPa, respectively, using velocity-interferometer techniques. To within the time resolution of the technique, the shock transition is found to occur within 3 ns in all materials. Based on this upper limit for the transition time, limiting viscosity coefficients of 1000, 3000, and 4000 P are obtained for 6061-T6 aluminum, OFHC copper, and 4340 steel, respectively, at strain rates above $10^8 s^{-1}$. It is found that the effective viscosity can be expressed as parameters in a Maxwellian relation for an elastic-plastic solid, in which the viscosity is related to an effective relaxation time. It is also shown that viscosity is inversely proportional to mobile-dislocation density, which implies that the density of mobile dislocations obtained during shock compression in these materials is well over $10^9/cm^2$.

41236 Investigation of the structure of rolled molybdenum single crystal in a diverging x-ray beam. Pronina, L.N.; Shmyt'ko, I.M.; Aristov, V.V. (Institute of Solid-State Physics, Academy of Sciences of the USSR, Chernogolovka, Moscow Province). *Sov. Phys. - Solid State (Engl. Transl.);* **20**: No. 11, 1960-1962(Nov 1978).

An investigation was made of changes in the substructure of Mo single crystals subjected to plastic deformation. When the total deformation exceeded 50%, there was an improvement in the structure characterized by a reduction in the block misorientation angles and a reduction in the local stresses and bending of the lattice inside each block.

41237 Fracture toughness of heavy-wall welded tankage steel. Ciuffreda, A.R. (ed.). New York, NY; American Society of Mechanical Engineers (1977). 100p. (CONF-770903—11).

From ASME energy technology conference on composites in pressure vessels and piping; Houston, TX, USA (18 Sep 1977).

Two papers are giveed which present a complete and unique characterization of the fracture toughness and fracture initiation resistance of welded ASTM-A537 steel plate used in large diameter oil storage tank construction. Separate abstracts were prepared for the two papers. (FS)

41238 Wide plate testing of heavy-wall welded tankage steel. Bagnoli, D.L. (Exxon Research and Engineering Co., Florham Park, NJ); Norris, E.B. pp 1-20 of Fracture toughness of heavy-wall welded tankage steel. Ciuffreda, A.R. (ed.). New York, NY; American Society of Mechanical Engineers (1977).

From ASME energy technology conference on composites in pressure vessels and piping; Houston, TX, USA (18 Sep 1977).

A wide plate test program assessed the fracture properties of A537 welded steel. Flaws simulated real life flaws sharpened by fatigue. Defects included part through cracks. Results showed that a stress above the minimum yield point could be sustained before failure. The strain level above 4 x yield strain was used as a strain criteria for minimum service temperature for structures loaded to a high percentage of yield. The Barsom-Wolfe correlation was found to show general agreement with values obtained. (FS)

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 41196, 41212, 41217, 41269, 41381, 41986, 41987, 41988, 41989

41239 (BNL—25912) **Synchrotron radiation photoemission studies of core level excitation effects.** Williams, G.P.; Lapeyre, G.J.; Anderson, J.; Cerrina, F.; Dietz, R.E.; Yafet, Y. (Brookhaven National Lab., Upton, NY (USA); Montana State Univ., Bozeman (USA). Dept. of Physics; Bell Labs., Murray Hill, NJ (USA)). 1979. Contract EY-76-C-02-0016. 21p. (CONF-790356—1). Dep. NTIS, PC A02/MF A01.

From European committee on surface science II; Cambridge, UK (26 Mar 1979).

The recent availability of intense polarized radiation tunable over the range 20-150 eV enables several core levels to be excited. Several remarkable effects have recently been reported when core excitation thresholds have been reached. For example, an increase in yield of 50% was observed in GaSe at the Se 3d threshold (h omega ≃ 57 eV). A considerable increase in photoemission intensity at 6 eV binding energy has been reported by Guillot et al. for Ni at the 3p threshold. A very careful study was made using the CIS, CFS, and EDC modes of photoemission spectroscopy of core threshold effects in Ni, Pt, and GaSe. A modulation of the Ni Fermi edge emission as a function of photon energy is found which is attributed to a configuration interaction between $3p^6 3d^{10} 4s$ and $3p^6 3d^8 4s \epsilon f$. Similar effects occur in Pt at the 4f threshold involving the configurations $4f^{13} 5d^{10} 6s$ and $4f^{14} 5d^8 6s$. Further, the lineshapes of the Pt and Ni upper valence band CIS's resemble those obtained by electron energy loss (ELS) and photoabsorption, all of which can be fitted theoretically to a Fano model. Emission from levels lying well below the Fermi level often has superimposed contributions due to incoherent effects which complicate the interpretation. In cases in which core levels are excited well above threshold, the CIS technique may be used to examinefinal states. Of particular interest is the possible consequent determination of adsorbate site geometry. Data are presented for 2p emission from a c(2x2) Na overlayer on Ni (001).

41240 (UCRL—52636) **Magnetic order in gold—iron alloys.** Borg, R.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Dec 1978. Contract W-7405-ENG-48. 33p. Dep. NTIS, PC A03/MF A01.

The magnetic behavior of the Au—Fe alloy system has been investigated extensively over several years by the author and his colleagues. This report is primarily a compilation of their research. Moessbauer spectroscopy results demonstrate the existence of magnetic order and define three regions of alloy composition which exhibit the Kondo effect, spin glass behavior, and dependence on snort-range order. Polarization and magnetization measurements also provide clues to magnetic behavior.

41241 Phonon linewidths and electron-phonon interaction in Nb. Bulter, W.H.; Pinski, F.J.; Allen, P.B. (Metals and Ceramics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., Sect. B. Condens. Matter;* **19**: No. 7, 3708-3721(1 Apr 1979).

We present first-principles calculations of the electron-phonon contribution to the phonon linewidth in Nb. The calculations employ a realistic band structure and the rigid-muffin-tin approximation for the electron-phonon matrix elements. The calculations predict strong electron-phonon coupling for longitudinal phonons propagating in the [110] direction, and for longitudinal phonons of momentum $q = 0.7(2\pi/a)[100]$. The origins of these peaks in the linewidth are discussed in terms of the joint Fermi-energy density of states and the symmetry properties of the electron-phonon matrix elements. Our results are in agreement with available experimental data concerning the mode and q dependence of the phonon linewidth and with empirical values of the electron-phonon coupling constant λ.

41242 Phonon dispersion relations in the disordered Ni/sub 1-x/ Pt/sub x/ system. Tsunoda, Y.; Kunitomi, N.; Wakabayashi, N.; Nicklow, R.M.; Smith, H.G. (Department of Physics, Faculty of Science, Osaka University, Toyonaka, Osaka, Japan 560). *Phys. Rev., Sect. B. Condens. Matter;* **19**: No. 6, 2876-2885(15 Mar 1979).

The phonon dispersion relations of the substitutional disordered alloys Ni/sub 1-x/Pt/sub x/ (x = 0.05, 0.30, 0.50, 0.75, and 0.95) were studied by neutron inelastic scattering. The resonance mode for the sample with x = 0.05 is well described by the mass-defect coherent-potential-approximation (MCPA) theory. Experimental results deviate from the MCPA calculations for the samples with x > or = 0.30 and the difference is most conspicuous for the maximum phonon frequency which decrease faster with increasing Pt concentration than the theory predicts. The energy splitting of the phonon dispersion curves at the resonance-mode frequency has a branch dependence in contrast to the MCPA prediction; that of the L branch alway takes place at a higher frequency than that for the T branch.

41243 Hyperfine-field distribution in Fe$_3$Si/sub 1-x/Al/sub x/ alloys and a theoretical interpretation. Burch, T.J.; Raj, K.; Jena, P.; Budnick, J.I.; Niculescu, V.; Muir, W.B. (Department of Physics, Marquette University, Milwaukee, Wisconsin 53233). *Phys. Rev., Sect. B. Condens. Matter;* **19**: No. 6, 2933-2938(15 Mar 1979).

In Fe$_3$Si/sub 1-x/Al/sub x/ alloys with small x the Si and Al nuclear magnetic resonances are 31.5 and 16.1 MHz, respectively. The concentration dependences of the frequencies of these resonances are linear, the Si resonance shifting to lower frequencies, the Al resonance to higher frequencies. Both the magnitudes and concentration dependences of the Si and Al internal fields are in agreement with the predictions of a simple model which Jena and Geldart, following the approach of Daniel and Friedel, have found successful in calculating the fields of sp elements in Heusler alloys. A positive sign is predicted for the Si internal field, and a negative sign for the Al field. Magnetization and lattice-parameter data required for the comparison of experiment and theory are also reported.

41244 Magnetic interactions in ternary superconductors. Shenoy, G.K.; Dunlap, B.D.; Fradin, F.Y.; Kimball, C.W.; Potzel, W.; Proebst, F.; Kalvius, G.M. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Appl. Phys.;* **50**: No. B3, 1872-1875(1 Mar 1979).

Numerous ternary superconductors containing rare-earth atoms have recently been studied in order to investigate the magnetic interactions between the conduction electrons and local magnetic moments. These investigations range from the evaluation of the strength of spin-flip scattering of the conduction electrons off the rare-earth moments to the problem of the coexistence of superconductivity and magnetic order. We present results of our studies on (Eu,Sn)Mo$_6$S$_8$, ErRh$_4$B$_4$, Er/sub 1-x/Ho/sub x/Rh$_4$B$_4$ and Er/sub 1-x/Gd/sub x/Rh$_4$B$_4$ using primarily the Moessbauer effect in ^{151}Eu and ^{166}Er, and nuclear magnetic resonance of ^{95}Mo. The paramagnetic hyperfine spectra of the rare-earth ions indicate a weak coupling of the 4f magnetic moment to the conduction electrons. The enhanced H/sub c2/ value in (Eu,Sn)Mo$_6$S$_8$ is found to be related to a negative s-band polarization at the Mo site. The magnetic moment on the Er atom in ErRh$_4$B$_4$ (and in related materials) in the magnetically ordered state is found to be about 8.3 μ/sub B/. This is 30% larger than that measured from neutron diffraction studies, indicating that only a component of the moment shows long-range magnetic order.

41245 Magnetism and superconductivity in rare-earth ternary borides. Freeman, A.J.; Jarlborg, T. (Northwestern University, Evanston, Illinois 60201). *J. Appl. Phys.;* **50**: No. B3, 1876-1879(1 Mar 1979).

The observation of magnetism and superconductivity in both the ternary rare-earth rhodium borides (MRh$_4$B$_4$) and the Chevrel phase ternaries M/sub x/Mo$_6$S$_8$ (with x close to 1) and most recently (i) the discovery of re-entrant magnetism accompanying a transition to a normal metallic state at T<T/sup s//sub c/ (the superconducting transition temperature) and (ii) the coexistence of magnetism and superconductivity have generated considerable excitement as to the origin of these phenomena. We discuss the origin of magnetism and superconductivity in the MRh$_4$B$_4$ compounds and re-entrant magnetism in ErRh$_4$B$_4$ using the results of ab initio self-consistent LMTO energy band calculations. The total and separate l-decomposed contributions to the density of states (DOS) arising from the two M, eight Rh and eight B atoms per unit cell are used to estimate their various contributions to magnetic ordering (via the 4f-5d RKKY interaction) and/or superconductivity (using a Gaspari-Gyorffy model to obtain the electronic contributions to λ, the electron-phonon coupling parameter, and McMillan strong coupling theory to obtain T/sup s//sub c/). Comparisons are made with recent experimental results and several experimental speculations about the re-entrant magnetism state are presented including the possibility of a mixed (ferromagnetic and superconducting) state.

41246 Neutron scattering observations on the magnetic phases of rare-earth ternary superconductors. Moncton, D.E. (Bell Laboratories, Murray Hill, New Jersey 07974). *J. Appl. Phys.;* **50**: No. B3, 1880-1884(1 Mar 1979).

A number of ternary compounds become superconducting even though they contain a chemically ordered sublattice of magnetic rare-earth ions. Studies of the physical properties of these materials have revealed anomalies below T/sub c/ which have been attributed to magnetic ordering transitions. Using neutron spectrometers at the Brookhaven National Laboratory, a group of us has demonstrated that simple magnetic structures with long-range order do occur, and we have solved some of the magnetic structures of these superconductors. Specifically, we have found that in DyMo$_6$S$_8$ and TbMo$_6$S$_8$ an antiferromagnetic structure coexists with superconductivity. In two other compounds, ErRh$_4$B$_4$ and HoMo$_6$S$_8$ we have found that the development of ferromagnetism is responsible for the quenching of superconductivity. A study of the critical magnetic neutron scattering near the superconducting → ferromagnetic transitions shows the presence of fluctuations into a state with an oscillatory magnetization of wave length λ=100 A.

41247 Self-consistent studies of magnetic thin film Ni (001) . Wang, C.S.; Freeman, A.J. (Northwestern University, Evanston, Illinois 60201). *J. Appl. Phys.;* **50**: No. B3, 1940-1943(1 Mar 1979).

Advances in experimental methods for studying surface phenomena have provided the stimulus to develop theoretical methods capable of interpreting this wealth of new information. Of particular interest have been the relative roles of bulk and surface contributions since in several important cases agreement between experiment and bulk self-consistent (SC) calculations within the local spin density functional formalism (LSDF) is lacking. We discuss our recent extension of the (LSDF) approach to the study of thin films (slabs) and the role of surface effects on magnetic properties. Results are described for Ni (001) films using our new SC numerical basis set LCAO method. Self-consistency within the superposition of overlapping spherical atomic charge density model is obtained iteratively with the atomic configuration as the adjustable parameter. Results are presented for the electronic charge densities and local density of states. The origin and role of (magnetic) surface states is discussed by comparison with results of earlier bulk calculations.

41248 Induced magnetic form factor of Ce/sub 0.736/Th/sub 0.264/ . Moon, R.M.; Koehler, W.C. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Appl. Phys.;* **50**: No. B3, 2089-2090(1 Mar 1979).

The polarized neutron technique has been used to study the spatial dependence of the induced magnetization in the alloy Ce/sub 0.736/Th/sub 0.264/ in both the γ and α phases. In the γ phase we observe a susceptibility in good agreement with bulk susceptibility measurements and with a Q dependence characteristic of Ce^{3+}. In the α phase a different Q dependence is observed which may be caused by a contribution to the susceptibility by the conduction electrons.

41249 Temperature dependence of the field induced magnetic form factor of CeSn$_3$. Stassis, C.; Loong, C.; McMasters, O.D.; Moon, R.M. (Ames Laboratory: USDOE and Departments of Physcis and Metallury, Iowa State University, Ames, Iowa 50011). *J. Appl. Phys.;* **50**: No. B3, 2091-2093(1 Mar 1979).

Polarized neutron scattering techniques have been used to study the spatial distribution and temperature dependence of the magnetization induced in a single crystal of CeSn$_3$ by a magnetic field of 42.5 kG. We find that in the 300—40 K temperature range the measured form factor is in good agreement with the free ion 4f magnetic form factor of Ce^{3+}. Below 40 K large deviations from a 4f magnetic form factor were observed. A satisfactory fit to the data below 40 K can be obtained by assuming that the induced magnetization contains a large component of 5d electronic character of e/sub g/ symmetry.

41250 Study of Fe-rich superparamagnetic clusters in olivine, (Mg,Fe)$_2$SiO$_4$ by Mossbauer spectroscopy. Rao, V.U.S.; Huggins, F.E.; Huffman, G.P. (Department of Energy, Pittsburgh, Pennsylvania 15213). *J. Appl. Phys.;* **50**: No. B3, 2408-2410(1 Mar 1979).

Mossbauer spectra of olivines of composition (Mg/sub x/Fe/sub 1-x/)$_2$SiO$_4$ (x=0.3 to 0.9) have been examined in the temperature range 4.2 to 300 K, and found to exhibit superparamagnetic relaxation effects originating from clusters of Fe^{2+} ions. Relaxation times were determined by comparison with theoretical relaxation spectra calculated from the stochastic model of Blume and Tjon, which was modified to include the asymmetry parameter and general orientations of the hyperfine field direction with respect to the crystal axes. From the variation of the relaxation time with temperature, the mean cluster-size diameters of the Fe-rich regions were found to be in the range 20 to 40 A, and to increase with increasing Fe content. The distribution of cluster diameters was asymmetric, with higher probabilities for small diameters. Potential applications with regard to the determination of the thermal histories of rocks containing olivine are discussed.

41251 Rules governing the behavior of the electrical resistivity and thermoelectric power of systems of binary continuous solid solutions of metals. Vedernikov, M.V.; Dvunitkin, V.G.; Zhumagulov, A. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of

the USSR, Leningrad). *Sov. Phys. - Solid State (Engl. Transl.);* **20**: No. 11, 1904-1906(Nov 1978).

A new experimental investigation was made of the electrical resistivity of ten systems of binary continuous solid solutions of metals at temperatures of 293 and 4.2°K. The systems were as follows: Cr—V, Mo—Nb, Mo—V, Cr—Mo, Nb—V, Ti—Zr, Hf—Zr, Hf—Ti, Sc—Zr, Sc—Hf. A comparative analysis of all the available data on the dependences of the resistivity on the composition of 21 systems of continuous solid solutions was made for the first time. The dependences were found to be of two types. The dependence of the first type was typical of the systems formed by two isoelectronic metals and that of the second type was observed for systems formed by nonisoelectronic metals. There were corresponding differences between the dependences of the thermoelectric power on the composition for these two types of solid solutions.

41252 Anisotropy of electrical resistivity of rare-earth metals. Raevskaya, L.T.; Abel'skii, S.S.; Irkhin, Y.P. (Institute of Metal Physics, Ural Scientific Center of the Academy of Sciences of the USSR, Sverdlovsk). *Sov. Phys. - Solid State (Engl. Transl.);* **20**: No. 11, 1928-1933(Nov 1978).

The molecular-field approximation is used to calculate the anisotropy of the magnetic component of the electrical resistivity, Δrho/sup i/j/sub mag/ /rho-bar /sup i/j/sub mag/=2 (rho/sup i// sub mag/-rho/sup j//sub mag/)/ (rho/sup i//sub mag/+rho/sup j//sub mag/) (i,j,= x, y, z), of the heavy rare-earth metals in the region of magnetic ordering. Three factors affect Δrho/sup i/j/sub mag//rho-bar /sup i/j/sub mag/: the effective-mass anisotropy, the anisotropy of carrier scattering by the disorder in the quadrupole moments of the 4f shells, and the anisotropy of the gap in the carrier spectrum due to the superband structure. The last two factors are temperature-dependent and the magnitude of their contributions to Δrho /sup i/j/sub mag//rho-bar /sup i/j/sub mag/ depends on the nature of the magnetic ordering and on the angle between the directions of the current and magnetization. The possibility of different combinations of signs can produce nonmonotonic variations and changes of sign in the temperature dependence of the resistivity anisotropy. At the transition to the paramagnetic region the value of Δrho /sup perpendicularz/ /sub mag// rho-bar /sup perpendicularz//sub mag/ agrees with that previously derived by the authors.

41253 Effects of changes in the valence state of atoms of rare-earth elements due to adsorption on transition metals. Nikulin, V.K.; Potekhina, N.D. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Phys. - Solid State (Engl. Transl.);* **20**: No. 11, 1936-1938(Nov 1978).

Experimental values of the adsorption energy of rare-earth atoms on tungsten [B. K. Medvedev, N. I. Ionov, and Yu. I. Belyakov, Sov. Phys. Solid State 15, 1743 (1974)] have, in the limit of zero surface coverage, a characteristic sawtooth dependence on the atomic number. This dependence is attributed to a change in the valence state of rare-earth atoms as a result of adsorption. The adsorption energies of these atoms, calculated on the assumption that they are in the trivalent state on the surface of a metal, make it possible to explain the characteristic sawtooth dependence on the atomic number and to obtain a very good agreement between the calculated and experimental energies. An analysis is made of the possibility that rare-earth atoms have an intermediate valence on the surface of metals. It is predicted that the intermediate valence state may be exhibited by the La atoms (valence~2.5) on the surfaces of the transition metals. The experimentally observed [M. S. Gupalo, V. K. Medvedev, T. P. Smereka, G. V. Babkin, and B. M. Palyukh, Sov. Phys, Solid State 19, 1731 (1977)] sudden changes in the heats of adsorption of La on W due to a change in the coverage are attributed to an electronic phase transition from the intermediate valence state. Experimental determination of the electronic states of rare-earth atoms on the surfaces of transition metals is considered: the application of the methods of photoelectron spectroscopy and of the well-tested method of chemical shifts of K x-ray lines [O. I. Sumbaev, Sov. Phys. Usp. 21, 141 (1978)] are discussed.

41254 Surface acoustic waves in tungsten. Tsymbal, L.T.; Pisarev, L.T.; Popovich, A.I.; Vitchinkin, V.T. (Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR, Donetsk). *Sov. Phys. - Solid State (Engl. Transl.);* **20**: No. 11, 1977-1979(Nov 1978).

An investigation was made of the velocity of surface ultrasonic waves (30-150 MHz) in tungsten and of the absorption of these waves in magnetic fields up to 55 kOe. Quantum oscillations of the absorption coefficient were used to obtain some information on the constant-energy surface of tungsten.(AIP)

41255 Critical magnetic fields of Nb_3Sn films on a dielectric substrate. Pan, V.M.; Popov, A.G. (Institute of Metal Physics, Academy of Sciences of the Ukrainian SSR). *Sov. J. Low Temp. Phys. (Engl. Transl.);* **4**: No. 10, 582-584(Oct 1978).

Temperature dependences of the upper critical field of Nb_3Sn films do not exhibit a paramagnetic limitation and are linear to T/T/sub c/~0.1 in a number of cases. Values of the upper critical field extrapolated to T=0 exceed 300 kG.

41256 New metastable superconducting modification of bismuth attainable in ultrathin films. Lazarev, B.G.; Semenenko, E.E.; Tutov, V.I.; Chupikov, A.A. (Khar'kov Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR). *Sov. J. Low Temp. Phys. (Engl. Transl.);* **4**: No. 8, 451-452(Aug 1978).

The superconductor properties of ultrathin (18—70 A) bismuth films were studied, these films having been produced by condensation of metal vapor on a surface cooled down to 2°K. It has been established that the superconducting transition temperature becomes higher after annealing of such films and that the magnitude of this upward shift is a function of the film thickness. The maximum shift is ΔT/sub c/=0.9°K for a film 18 A thick, the shift is smaller for films thicker than that, until there is no shift for films thicker than 40 A. The highest superconducting transition temperature after annealing of all specimens of all thicknesses did not exceed 3.6°K. These data as well as the previously known anomalous dependence of dH/sub c//dT, electrical resistivity, and coordination structure of freshly condensed thin bismuth films on their thickness suggest that such films thinner than 40 A form as a different modification than that of thicker films. The hypothesis is proposed here that this modification is a distorted variant of the high-pressure Bi-II phase.

41257 Temperature and magnetic-field dependence of the vortex-pinning force with wide variation of j/sub c/. Borka, S.; Goncharov, I.N.; Khukhareva, I.S. (Joint Institute of Nuclear Research). *Sov. J. Low Temp. Phys. (Engl. Transl.);* **4**: No. 8, 453-456(Aug 1978).

The behavior of the pinning forces in cold-deformed strips of Nb—80% Zr alloy was investigated for different angles between the sample plane and the magnetic-field direction (with jperpendicularH) over practically the whole region of existence of the mixed state. The strong angular dependence of the critical current permitted controlled changes to be made in the pinning force F/sub c/ over a broad range. The transition from curves of F/sub c/(h)/sub t/,phi with a peak close to H/sub c/2 to the dome-like curves corresponding to small angles phi was investigated. The temperature dependence of the pinning force was found. In discussing the results, it was assumed that the change in the shape of F/sub c/(h)/sub t/ ,phi with change in phi is associated with a transition from the "lattice" approximation (in moderate magnetic fields) to the "liquid" approximation.

41258 Resistive states of superconductive films and the voltage switching effect in tunnel systems. Ivanchenko, Y.M.; Khirnyi, V.F. (Donetsk Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR). *Sov. J. Low Temp. Phys. (Engl. Transl.);* **4**: No. 8, 456-459(Aug 1978).

An explanation is offered for the voltage-switching effect in tunnel systems, based on a study of the resistive state in superconductive aluminum films.

41259 Coexistence of superconductivity and ferromagnetism in layered systems. Pashitskii, E.A.; Shpigel', A.S. (Institute of Physics, Academy of Sciences of the Ukrainian SSR). *Sov. J. Low Temp. Phys. (Engl. Transl.);* **4**: No. 8, 460-464(Aug 1978).

It is shown for layered systems that when the electronic concentration varies monotonically from layer to layer the homogeneous superconducting electron pairing of adjacent layers with antiparallel spins is accompanied by a spontaneous ferromagnetic ordering (the SF-phase), while in the case of nonequivalent alternating layers a paramagnetic superconducting state (the SP-phase) is generated for certain magnetic fields H and chemical potential differences $\delta\mu$ between adjacent layers. The paramagnetic limit grows with increasing $\delta\mu$, and the transition from the normal to the superconducting (SF or SP) state is a first order phase transition both in the field H and in $\delta\mu$.

41260 Superconductive properties of the system gallium—dielectric, produced by shock compression. Alekseevskii, V.P.; Balbanov, E.I.; Bespalov, B.P.; Gakel', V.R.; Kostromin, A.S.; Mikheev, V.A.; Pechentkovskaya, L.E.; Titov, V.V.; Yarosh, V.V. (Scientific Research Institute of Organic Intermediate Products and Dyes, Moscow). *Sov. J. Low Temp. Phys. (Engl. Transl.);* **4**: No. 8, 509-510(Aug 1978).

A finely dispersed modification of gallium which transforms to the superconductive state at T< or =6.1°K was produced by shock compression of the systems Ga—[Qn-$TCNQ_2$] and Ga—glass. By comparing the superconductive parameters of the modification obtained with corresponding parameters of similar finely dispersed systems the modification was identified as the gallium β-phase. This β-phase, obtained by shock compression of a gallium—dielectric system, is stable with respect to repeated heating and lengthy maintenance at room temperature.

41261 Superconducting temperatures of quenched thorium-zirconium alloys. Peterson, D.T.; Ostenson, J.E. (Ames Lab., IA (USA));

Taylor, W.A. (California State Univ., Los Angeles (USA)). *J. Less-Common Met.;* **60**: No. 1, 115-121(Jul 1978).

The superconducting transition temperatures of thorium-zirconium alloys containing 66-100 at.% Zr and quenched from the β region were determined. These alloys were b.c.c. at high temperature but quenching resulted in f.c.c., b.c.c. orthorhombic and h.c.p. structures. All these phases had superconducting transition temperatures above those of pure thorium or zirconium. No evidence for an ω phase was observed.

41262 Enthalpy and specific heat of a nickel—cobalt steel to 2000 K. Stephens, H.P. (Sandia Labs., Albuquerque, NM). *High Temp. Sci.;* **10**: No. 2, 95-107(Jun 1978).

The enthalpy and specific heat of the solid and liquid phases of a 9% Ni, 4% Co, 0.2% C steel determined to 2000 K by a combination of differential-scanning and liquid-argon-vaporization calorimetry techniques. Presence of the α to γ phase transition between 950 and 1040 K was found to complicate the temperature functionality of both the enthalpy and specific heat of the solid material. The specific heat showed an increase from 0.11 cal $g^{-1} K^{-1}$ at 298 K to 0.34 at 990 K, a sharp decrease to 0.13 at 1040 K, then a linear increase to 0.19 cal $g^{-1} K^{-1}$ at the solidus temperature. In contrast, the enthalpy of the liquid phase was found to be a linear function of temperature, indicating a consant specific heat (0.20 cal $g^{-1} K^{-1}$). The heat of fusion, 55 cal g^{-1}, was calculated from the difference between the enthalpy of the solid and liquid phases at the solidus point, 1711 K. 17 references.

41263 Sublattice magnetization of $ErFe_2$—H. Rhyne, J.J. (National Bureau of Standards, Washington, DC); Sankar, S.G.; Wallace, W.E. pp 63-68 of Rare earths in modern science and technology. McCarthy, G.J.; Rhyne, J.J. (eds.). New York, NY; Plenum Press (1978).

From 13. rare earth research conference; Olgebay Park, WV, USA (16 Oct 1977).

$ErFe_2$ has been found to absorb hydrogen readily and to exhibit a stable phase with composition near $ErFe_2H_4$. In this study $ErFe_2H_{4.5}$ which exhibits a Curie temperature of 450°K significantly depressed from the 574°K found for pure $ErFe_2$ was examined. At low temperature the magnetization does not saturate even in fields as large as 120 kOe. Neutron scattering results show that at 10°K the Er sublattice moment is 5.5 μ/sub B/ which is sharply lower than the free ion value of 9 μ/sub B/ found in pure $ErFe_2$. The Er moment decreases rapidly as the temperature is raised and is essentially zero at 300°K, well below the overall Curie temperature of 450°K. The iron moment on the other hand is 1.6 μ/sub B/ at low temperatures in agreement with that found in pure $ErFe_2$ and remains essentially constant up to 350°K before dropping rapidly to zero at the bulk Curie temperature. These results suggest a significant reduction in the Er—Er and Er—Fe exchange interactions on hydriding leading to a structure in which the rare earth is very loosely coupled.

41264 Effect of rare earth and transition metal substitution on the anisotropy of R_2Co_{17} compounds (R = Er, Tm, Yb). Merches, M.; Narasimhan, K.S.V.L.; Wallace, W.E. (Univ. of Pittsburgh, PA). pp 409-414 of Rare earths in modern science and technology. McCarthy, G.J.; Rhyne, J.J. (eds.). New York, NY; Plenum Press (1978).

From 13. rare earth research conference; Olgebay Park, WV, USA (16 Oct 1977).

Pr, Fe, and Mn substitutions in R_2Co_{17} compounds (R = Er, Tm, Yb) have been investigated by x-ray and thermomagnetic measurements. Pr substitution changes the preference of easy axis of magnetization from c-axis to the basal plane. The substitution of iron and manganese for cobalt permits substitution to x = 1.6 in the formula Er/sub 2-x/Pr/sub x/Co_{17} without altering the c-axis preference. Mn substitution results in initial increase in the magnetization but the Curie temperature decreases rapidly.

41265 Pressure coefficients for band gaps in silicon. de Alvarez, C.V.; Cohen, M.L. (Univ. of California, Berkeley). *Solid State Commun.;* **14**: 317-320(1974).

The pressure coefficients of the main gaps in Si, using the Empirical Pseudopotential Method (EPM) was calculated. A trend toward metallization at high hydrostatic pressures was found. The deformation potential at the top of the valence band for uniaxial stress along the (0,0,1) direction was obtained. All of the calculated pressure coefficients are in good agreement with experiment.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 40088, 40097, 40160, 40265, 40266, 40811, 40830

41266 (CONF-790145—1) **Mechanical behavior of oxide scales.** Cathcart, J.V.; Pawel, R.E. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 29p. Dep. NTIS, PC A03/MF A01.

From Meeting on erosion-corrosion of materials in coal conversion systems; Berkeley, CA, USA (24 Jan 1979).

Stresses in the range 10^2 to 10^4 MPa (10^4 to 10^6 psi) frequently develop in growing oxide scales on metals and alloys. The importance of the oxide-to-metal volume ratio, the mode of diffusion in the oxide, the oxide morphology, specimen geometry, and other parameters in stress generating mechanisms is discussed, and important mechanisms of stress relaxation are also reviewed. Emphasis is placed on the interaction of several of the above parameters.

41267 (CONF-790313—2) **Design and operation of thermal-convection loops for corrosion measurements in LiF—LiCl—LiBr.** Keiser, J.R.; DeVan, J.H. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 10p. Dep. NTIS, PC A02/MF A01.

From NACE/Corrosion 1979 meeting; Atlanta, GA, USA (12 Mar 1979).

Using a most sophisticated design of a thermal-convection loop to study the corrosion behavior of type 316 stainless steel and the salt mixture LiF—LiCl—LiBr is reported. The corrosion rate is being determined as a function of time and temperature through weight change measurements. The maximum corrosion rate measured is about 20 μm/year on removable corrosion specimens. Controlled potential voltammetry has been found to be satisfactory and is being used to monitor the oxidation potential of the salt. Measurements demonstrate the effect on the oxidation potential of impurities introduced during specimen insertion, and techniques should show the effect of a lithium addition on the oxidation potential.

41268 (COO—2305-6) **Electron-dislocation interaction at low temperatures. Progress report.** (Connecticut Univ., Storrs (USA). Inst. of Materials Science). 1978. Contract EY-76-S-02-2305. 57p. Dep. NTIS, PC A04/MF A01.

In the last year we have shown that dislocations in aluminum are slowed down by magnetic fields, with the drag varying as H^2, and the drag is independent of temperature. We have also shown that the flux motion, in the mixed state of superconductors can be used to measure the mobile dislocation density over a wide range of strains and stresses. These results show, for the first time how to measure the mobile dislocation density in a tensile test.

41269 Application of a photogrammetric technique to the determination of the orientation of stress-corrosion fractures. Nelson, J.L. (Inco Research and Development Center, Suffern, NY); Beavers, J.A. *Metall. Trans., A;* **10A**: No. 5, 658-662(May 1979).

The orientations of the stress-corrosion-fracture planes of Al-5.6 wt % Zn-2.6 wt % Mg alloy and Admiralty metal are reported.

41270 Materials problems experienced at the Synthane coal-gasification pilot plant. Danyluk, S. (Argonne National Lab., IL); Dragel, G.M.; Dubis, D. *J. Eng. Mater. Technol.;* **101**: No. 2, 105-113(Apr 1979).

Some failure experiences with metallic components at the synthane coal-gasification pilot plant are presented. In some cases, corrosion caused by a sulfur environment was a major factor in the failure initiation. Several instances of improper component manufacture or heat treatment led to failures. Chloride-assisted stress-corrosion cracking and an improper materials choice contributed to two cases of failure. In most cases, the recommended changes in materials, design or process conditions have resulted in an increase in component life.

41271 Mechanical nature of stress-corrosion cracking in Al—Zn—Mg alloys. II Electrochemical-mechanical model. Gerberich, W.W.; Wood, W.E. (Lawrence Radiation Lab., Berkeley, CA). *Metall. Trans.;* **5**: 1295-1304(Jun 1974).

Slow crack growth during SCC of 7075 aluminum has been shown to comprise both an electrochemical and a mechanical component. These findings prompted a review of several possible mechanical models, and seven possible controlling thermally-activated processes. Since no existing interpretation could satisfy all of the observations, an empirical model was developed. The conclusion is that slight modification of many existing proposed mechanisms could explain the general features of SCC but that any theoretical model must contain some aspect of the mechanical rupture process.

41272 Mechanical nature of stress-corrosion cracking in Al—Zn—Mg alloys. I Evaluation of the ductile rupture contribution. Wood, W.E.; Gerberich, W.W. (Univ. of California, Berkeley). *Metall. Trans.;* **5**: 1285-1294(Jun 1974).

A detailed study of rapid stress-corrosion-cracking (SCC) in a 7075 aluminum alloy has allowed separation of the mechanical and chemical contributions. This was accomplished by combining scanning electron microscopy, stress-wave emission and crack growth rate observations as a function of test temperature. These established an activation energy of 11.2 kcal/mol, a stress-intensity squared dependence of crack growth, and a range of 20 to 80 pct dimpled rupture on the fracture surfaces. Thus a two-step crack growth

mechanism is proposed combining a thermally activated electrochemical process and a discontinuous mechanical jumping process.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 40892, 41576, 41986, 42126

41273 (CONF-770807—Pt.L, pp vp) **Irradiation enhanced diffusion and irradiation creep tests in stainless steel alloys.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A review is given of investigations on the rate of phase changes during neutron and electron irradiation in many different fcc alloys showing either precipitation or ordering. The diffusion rate was determined as a function of the irradiation flux, the irradiation temperature and the irradiation dose. It was found that the radiation enhanced diffusion in all the investigated alloys is nearly temperature independent and linearly dependent on the flux. From these results conclusions were drawn concerning the properties of point defects and diffusion mechanisms rate determining during irradiation, which appears to be of a common nature for fcc alloys having a similar structure to those investigated. It has been recognized that the same dependencies which are found for the diffusion rate were also observed for the irradiation creep rate in stainless steels, as reported in literature. On the basis of this observation a combination of measurements is suggested, of radiation enhanced diffusion and radiation enhanced creep in stainless steel alloys. The diffusion tests will be performed at the Euratom Joint Research Centre in Ispra, Italy, and the irradiation creep tests will be carried out in the High Flux Reactor /9/ of the Euratom Joint Research Centre in Petten, The Netherlands. In order to investigate irradiation creep on many samples at a time two special rigs were developed which are distinguished only by the mode of stress applied to the steel specimens. In the first type of rig about 50 samples can be tested uniaxially under tension with various combinations of irradiation temperature and stress. The second type of rig holds up to 70 samples which are tested in bending, again with various combinations of irradiation temperature and stress.

41274 (GEFR-SP—153) **Comparison of neutron irradiation and nickel ion bombardment in the production of swelling in AISI 316 stainless steel.** Lauritzen, T.; Appleby, W.K.; Bell, W.L. (General Electric Co., Sunnyvale, CA (USA)). 5 Apr 1979. Contract EY-76-C-03-0893-031. 13p. (CONF-790616—1). Dep. NTIS, PC A02/MF A01.

From Conference on irradiation behavior of metallic materials for fast reactor core components; Ajaccio, France (4 Jun 1979).

The high fluence swelling behavior of AISI 316 steel was studied by nickel—ion bombardment of unirradiated and low-fluence reactor preconditioned material and compared with that of high fluence material irradiated in EBR-II. A comparison of swelling rates produced by the two bombarding species shows that the swelling response per dpa produced by nickel ions and neutrons is equivalent at comparable temperatures.

41275 (LA—7811-MS) **Analytic method for calculating the time—temperature history of metal foils under pulsed irradiation and a Gaussian beam profile.** Kmetyk, L.N.; Sommer, W.F. (Los Alamos Scientific Lab., NM (USA)). May 1979. Contract W-7405-ENG-36. 17p. Dep. NTIS, PC A02/MF A01.

Utilization of a pulsed radiation source such as the Clinton P. Anderson Meson Physics Facility (LAMPF) for materials science studies requires knowledge of the time—temperature history of a subject metal foil. An analytic solution was derived to a two-dimensional heat flow equation, incorporating the LAMPF time structure and the LAMPF Gaussian beam spot profile. This calculational method is useful in designing experimental systems for materials science studies and can be done on a Hewlett—Packard model 97 desk-top calculator. The results were compared with an equivalent numerical solution of the same two-dimensional heat flow problem done on a digital computer.

41276 **Influence of impurity-defect interactions on radiation hardening and embrittlement.** Wechsler, M.S. (Ames Lab., IA). *J. Eng. Mater. Technol.;* **101**: No. 2, 114-121(Apr 1979).

From ASME/CSME pressure vessels and piping conference; Montreal, Canada (25 Jun 1978).

It has been established that copper and other trace elements have a detrimental effect on the notch-impact properties of ferritic pressure vessel steels irradiated at reactor operating temperatures of about 288°C (550°F). The underlying cause, however, of this trace element effect has not been established. But based on radiation damage work on vanadium containing oxygen and iron containing nitrogen, a possible mechanism appears to involve stabilization of radiation-produced defects as a result of migration of impurity atoms to the defects where they become trapped. The evidence for this impurity-defect interaction in vanadium and iron is described, and its effect on radiation hardening and embrittlement is discussed. The influence of dislocation channeling in promoting the early onset of plastic instability is also discussed, and the possible relevance of dislocation channeling is indicated with regard to the radiation-produced increase in ductile-brittle transition temperature and decrease in ductile shelf energy.

41277 **Radiatsionnye effekty izmeneniya mekhanicheskikh svoisty konstruktsionnykh materialov imetody ikh issledovaniya. (Radiation effects of the change in the mechanical properties of construction materials and methods of investigating them).** Pisarenko, G.S. (ed.). Kiev, USSR; Izdatel'stvo Naukova Dumka (1977). 172p.

From 2. All-Union conference on the radiation effects of the change in the mechanical properties of construction materials and methods of investigating them; Kiev, USSR (Apr 1976).

The collection contains papers presented at the 2nd All-Union Conference on the Radiation Effects of the Change in the Mechanical Properties of Construction Materials and Methods of Investigating Them (Kiev, April 1976). An examination is made of experimental studies of the change in the mechanical properties of construction materials, characteristics of creep and the long-term strength of irradiated steels and alloys, the kinetics of radiation damage accumulation, the development of original methods and building of equipment for intra-reactor investigations of the physico-mechanical properties of fuel and construction materials, and a number of other problems. The collection is designed for designers and engineering-technical personnel in nuclear energy machine building, and scientific associates engaged in radiation material studies.

41278 **Experimental study of the effect of reactor irradiation on creep resistance and long-term strength of high-temperature steels.** Pisarenko, G.S.; Kiselevskii, V.N.; Kovalev, V.V. pp 3-12 of Radiatsionnye effekty izmeneniya mekhanicheskikh svoisty konstruktsionnykh materialov i metody ikh issledovaniya. Pisarenko, G.S. (ed.). Kiev, USSR; Izdatel'stvo Naukova Dumaka (1977). (In Russian)

From 2. All-Union conference on the radiation effects of the change in the mechanical properties of construction materials and methods of investigating them; Kiev, USSR (Apr 1976).

New experimental data are presented on the effect of radiative irradiation on the characteristics of creep and long-term strength of two types of steels. Creep resistance and long-term destruction of the irradiated material were shown to be dependent upon the level of the intensity of fast and thermal neutrons and on the energy spectrum of the irradiating currents. 13 references, 9 figures.

41279 **Study of the durability of irradiated steels with respect to the mechanics of a continuous medium.** Kiselevskii, V.N.; Kosov, B.L. pp 12-29 of Radiatsionnye effekty izmeneniya mekhanicheskikh svoisty konstruktsionnykh materialov i metody ikh issledovaniya. Pisarenko, G.S. (ed.). Kiev, USSR; Izdatel'stvo Naukova Dumka (1977). (In Russian)

From 2. All-Union conference on the radiation effects of the change in the mechanical properties of construction materials and methods of investigating them; Kiev, USSR (Apr 1976).

A description is given of the durability of a material at various flows of irradiation and at a complex stress state of the irradiated material on the basis of general methods of introducing new parameters into the state equation. An experimental verification of the description of durability during variable irradiating flows of fast and thermal neutrons demonstrated the correctness of the proposed correlations by more than an order of two with respect to intensity, and by 150 times with respect to ratios. 10 references, 2 figures, 2 tables.

41280 **Relationship between the effect of reactor irradiation on the durability of steel 0Kh16N15M3B and the operating parameters of the experiment.** Losev, N.P.; Rogozyanov, A.Ya.; Samsonov, B.V. pp 30-36 of Radiatsionnye effekty izmeneniya mekhanicheskikh svoisty konstruktsionnykh materialov i metody ikh issledovaniya. Pisarenko, G.S. (ed.). Kiev, USSR; Izdatel'stvo Naukova Dumka (1977). (In Russian)

From 2. All-Union conference on the radiation effects of the change in the mechanical properties of construction materials and methods of investigating them; Kiev, USSR (Apr 1976).

Results are given for the study of the effect that reaction irradiation has on the durability of steel grade 0Kh16N15M3B at various intensities of neutron flux and temperature. Irradiation was shown to reduce durability, all the more so when the neutron flux is greater. When only thermal and fast neutrons are taken into consideration, the effect of the former is shown to have a greater effect on durability than the latter. 5 references, 3 figures, 4 tables.

41281 **Kinetic equation of damage accumulation in materials exposed to the joint effects of stress field, temperature, and irradiation.** Tutnov, A.A. pp 36-45 of Radiatsionnye effekty izmeneniya mekhanicheskikh svoisty konstruktsionnykh materialov i metody ikh issledo-

vaniya. Pisarenko, G.S. (ed.). Kiev, USSR; Izdatel'stvo Naukova Dumka (1977). (In Russian)

From 2. All-Union conference on the radiation effects of the change in the mechanical properties of construction materials and methods of investigating them; Kiev, USSR (Apr 1976).

An equation is derived for computing the durability of materials operating under constant loads and at stage-wise cyclic stress under reactor conditions. A method is shown for experimentally determining the coefficients in the derived equation. An example is given of calculating the essential coefficients for computing the durability of steel grade KhN70VMTYu at a temperature of 700°C without irradiation. 4 references, 3 figures.

41282 Effect of neutron irradiation on the low-cycle fatigue of construction steels. Vinodurov, V.F.; Leskova, T.I. pp 59-66 of Radiatsionnye effekty izmeneniya mekhanicheskikh svoisty konstruktsionnykh materialov i metody ikh issledovaniya. Pisarenko, G.S. (ed.). Kiev, USSR; Izdatel'stvo Naukova Dumka (1977). (In Russian)

From 2. All-Union conference on the radiation effects of the change in the mechanical properties of construction materials and methods of investigating them; Kiev, USSR (Apr 1976).

Neutron irradiation was shown to lead to a reduction in the number of cycles prior to destruction, and to a significant fall in accumulative deformation in the sample cuts of a high-strength 12KhNZMA type steel and medium strength steel of the 10KhSND (SKhD-4) grade. Factorographic studies and investigations of the destruction kinetics by the electro-resistance method indicate a change in the nature of destruction and in the rate of fracture growth of low-cycle fatigue in irradiated steel. 3 references, 7 figures.

41283 Static and low-cycle durability of 15KhZMFA steel following neutron irradiation and hydrogen absorption. Alekseenko, N.N.; Vinokurov, V.F.; Kusnetsov, A.A.; Nikolaev, V.A.; Razov, I.A.; Usatov, E.P. pp 66-75 of Radiatsionnye effekty izmeneniya mekhanicheskikh svoisty konstruktsionnykh materialov i metody ikh issledovaniya. Pisarenko, G.S. (ed.). Kiev, USSR; Izdatel'stvo Naukova Dumka (1977). (In Russian)

From 2. All-Union conference on the radiation effects of the change in the mechanical properties of construction materials and methods of investigating them; Kiev, USSR (Apr 1976).

Neutron irradiation at 100 to 150°C under conditions of low-cyclic stress was found to reduce significantly durability and the conventional limit of low-cyclic fatigue of steel that contains hydrogen whereas these characteristics change insignificantly in irradiated steel that does not contain hydrogen. Irradiation at 300 to 350° practically does not change the steel's resistance to low-cyclic fatigue, regardless of hydrogen content. 20 references, 5 figures, 1 table.

41284 Role of admixtures in radiative embrittlement of ferrite—perlite steel. Nikolaev, V.A.; Badanin, V.N. pp 75-85 of Radiatsionnye effekty izmeneniya mekhanicheskikh svoisty konstruktsionnykh materialov i metody ikh issledovaniya. Pisarenko, G.S. (ed.). Kiev, USSR; Izdatel'stvo Naukova Dumka (1977). (In Russian)

From 2. All-Union conference on the radiation effects of the change in the mechanical properties of construction materials and methods of investigating them; Kiev, USSR (Apr 1976).

An explanation is given of experimental data that characterize the effects of admixtures and alloying elements on the radiation damage of low-alloy steel and binary iron alloys, based on the hypothesis that the complex radiation defects that are formed during irradiation are admixture segregates, and the amount of these defects and the extent of their concentration of admixture atoms depends on the content of alloying elements. An examination is made of the connection between the observed defects and the characteristics of the electron structure of the elements. 27 references, 7 figures, 1 table.

41285 Gas evolution during uranium dioxide creep in irradiation. Miloserdin, Yu.V.; Minaev, E.M.; Naboichenko, K.V.; Zolotukha, Yu.S. pp 107-115 of Radiatsionnye effekty izmeneniya mekhanicheskikh svoisty konstruktsionnykh materialov i metody ikh issledovaniya. Pisarenko, G.S. (ed.). Kiev, USSR; Izdatel'stvo Naukova Dumka (1977). (In Russian)

From 2. All-Union conference on the radiation effects of the change in the mechanical properties of construction materials and methods of investigating them; Kiev, USSR (Apr 1976).

Along with a method for the simultaneous investigation of fuel materials creep and the dynamics of gaseous fission product release at high temperatures (1000 to 1400°C) in the process of irradiation, an examination is made of the construction of the experimental chambers Kapriz-V1 and the Kapriz-H1 for the IRT-2000 reactor of the Moscow Physics Institute, and experimental results are given on creep and gas evolution of samples from UO_2 with ^{235}U enrichment. 3 references, 8 figures.

41286 Method of accelerated determination of the creep and relaxation characteristics of construction materials during low-cyclic stress in the irradiation process. Miloserdin, Yu.V.; Semenov, B.D.; Chechko, V.N. pp 119-126 of Radiatsionnye effekty izmeneniya mekhanicheskikh svoisty konstruktsionnykh materialov i metody ikh issledovaniya. Pisarenko, G.S. (ed.). Kiev, USSR; Izdatel'stvo Naukova Dumka (1977). (In Russian)

From 2. All-Union conference on the radiation effects of the change in the mechanical properties of construction materials and methods of investigating them; Kiev, USSR (Apr 1976).

An examination is made of a method of studying the effect of irradiation on a complex of mechanical characteristics determined from the results of short-term mechanical tests on a small number of samples. The basic principles of the method were verified in torsion tests of continuous and tubular samples from a series of fusible materials. 4 references, 3 figures.

41287 Low-temperature fatigue tests of materials in the zone of reactor irradiation. Vadachkoriya, L.A.; Demurov, D.G.; Katsitadze, D.G.; Mumladze, Sh.A.; Naskidashvili, I.A.; Tavkhelidze, G.P.; Chachanidze, R.F. pp 126-134 of Radiatsionnye effekty izmeneniya mekhanicheskikh svoisty konstruktsionnykh materialov i metody ikh issledovaniya. Pisarenko, G.S. (ed.). Kiev, USSR; Izdatel'stvo Naukova Dumka (1977). (In Russian)

From 2. All-Union conference on the radiation effects of the change in the mechanical properties of construction materials and methods of investigating them; Kiev, USSR (Apr 1976).

A description is given of a method and equipment which make it possible to investigate construction materials for expansion and fatigue in the low-cyclic elasto-plastic region under reactor irradiation conditions at low temperatures. The equipment creates conditions for intra-channel low-temperature tests of micro-sample batches for determining the effect of the test parameters on the durability and fatigue properties of the material in broad temperature range (20°K and higher) and the cyclic parameters of stress. 20 references, 5 figures.

41288 Method of investigating creep and long-term durability of construction materials under reaction irradiation conditions and dissociative heat transfer. Kiselevskii, V.N.; Tishchenko, S.S.; Lukashev, V.K.; Gol'tsev, V.P.; Rytvinskii, A.I. pp 135-144 of Radiatsionnye effekty izmeneniya mekhanicheskikh svoisty konstruktsionnykh materialov i metody ikh issledovaniya. Pisarenko, G.S. (ed.). Kiev, USSR; Izdatel'stvo Naukova Dumka (1977). (In Russian)

From 2. All-Union conference on the radiation effects of the change in the mechanical properties of construction materials and methods of investigating them; Kiev, USSR (Apr 1976).

A description is given of a method sample stress and possible load variability, and measurement of a sample's deformation prior to breakdown during the conduct of the experiment. Also described are the heating and maintenance of temperature on the samle within the assigned circulation limits of the coolant N_2O_4 at a temperature of 650°C and pressure of 50 kg/cm². The Neutron-7 apparatus was built on the basis of the developed method and makes it possible to investigate creep and durability of construction materials in the research channel of the IRT-M reactor under high temperature and dissociative heat transfer conditions. 6 references, 5 figures, 1 table.

CERAMICS, CERMETS, AND REFRACTORIES

REFER ALSO TO CITATION(S) 40847, 41195

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 40264, 40359, 40857, 40891, 41200, 41205, 41206, 41298, 41299, 41329

41289 (COO—1198-1261) **Growth of bismuth tungstate single crystals.** De L'Eprevier, A.G. (Illinois Univ., Urbana (USA). Materials Research Lab.). 1979. Contract EY-76-C-02-1198. 7p. (CONF-790420—11). Dep. NTIS, PC A02/MF A01.

From International symposium on ceramics in nuclear waste management; Cincinnati, OH, USA (30 Apr 1979).

Large single crystals of Bi_2WO_6 were grown, which will permit a complete characterization of the compound. The crystals have a mica like morphology with $(Bi_2O_2)^{2+}$ layers interleaved with $(WO_2)^4$ layers stacked in the c direction. The structure at room temperature is orthorhombic mm^2 with unit cell parameters a = 5.457A; b = 5.435A; c = 16.427A. Before melting congruently at 1800°C, Bi_2WO_6 has a disruptive phase transformation in the range of 860-960°C. Single crystals cannot be obtained from the melt. Hydrothermal and flux growth of Bi_2WO_6 are described. (FS)

41290 (IS-M—196) **Characterization of metastable tetragonal hafnia.** Hunter, O. Jr.; Scheidecker, R.W.; Tojo, S. (Ames Lab., IA

(USA)). 1979. Contract W-7405-ENG-82. 14p. (CONF-790526—1). Dep. NTIS, PC A02/MF A01.

From 4. international meeting on modern ceramic technologies; St Vincent, Italy (28 May 1979).

Conditions for retaining metastable tetragonal HfO_2 at room temperature were determined. Mechanical properties were measured as a function of the fraction retained metastable HfO_2 as well as porosity. The metastable phase was retained by (1) thermal decomposition of pure $Hf(OH_4)$ or $HfOCl_2$ and (2) hot pressing of HfO_2 + 1% Er_2O_3. The critical size for retaining pure tetragonal HfO_2 at room temperature in a stress free condition is 100A, whereas the critical size for the 1% Er_2O_3 hot pressed composition is significantly larger. The elastic moduli were found to vary linearly with porosity and showed a small effect due to the metastable phase presence.

41291 (SAND—78-2071C) CVD borides of the form (Ti, Zr)B_2 and (Ta, Ti)B_2. Randich, E. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract AC04-76DP00789. 12p. (CONF-790442—9). Dep. NTIS, PC A02/MF A01.

From International conference on metallurgical coatings; San Diego, CA, USA (23 Apr 1979).

ZrB_2, (Ti, Zr)B_2 and (Ta, Ti)B_2 have been synthesized in the temperature range of 1073 K to 1373 K using chemical vapor deposition procedures. The materials were produced as fully dense coatings on graphite using the hydrogen reduction of BCl_3 and the respective metal chloride(s). It was not possible to deposit pure TaB_2 but a phase identified as Ta_2B was formed when both $TiCl_4$ and $TaCl_5$ were present in the reactant gas mixture. Hardness measurements of the various boride phases gave the following VHN_{25} values (kg/mm^2): ZrB_2-2200, (Ti, Zr)B_2- ~ 3700 (maximum), Ta_2B-2430, and $(Ta_{.75}Ti_{.25})B_2$-3100.

41292 (SAND—79-0045C) Stresses in sputter deposited nickel and copper oxide thin films. Plunkett, P.V.; Johnson, R.M.; Wiseman, C.D. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 13p. (CONF-790442—2). Dep. NTIS, PC A02/MF A01.

From International conference on metallurgical coatings; San Diego, CA, USA (23 Apr 1979).

The total induced stresses were determined in nickel and copper oxide thin film deposited on copper substrates by sputtering. For nickel films, the stresses were determined as a function of film thickness and initial substrated temperature. For copper oxide films, stresses were determined as a function of film thickness and oxygen partial pressure during the deposition cycle. Nickel films exhibited tensile stresses in all cases; however, stresses decreased by 50% for initial substrate temperatures of 673°K compared to deposition at ambient temperatures. Copper oxide films could readily be produced in tension or compression depending on the amount of oxygen present during deposition. Both nickel and copper oxide films approached constant stress values for films thicker than approximately 0.7 micrometers.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 40857, 40891, 41289, 41324, 41326, 41329

41293 Nuclear magnetic resonance studies of ^1H in zirconium halide hydrides: Shielding tensors. Dubois Murphy, P.; Gerstein, B.C. (Ames Laboratory, U.S. Department of Energy, and Department of Chemistry, Iowa State University, Ames, Iowa 50011). *J. Chem. Phys.;* **70**: No. 10, 4552-4556(15 May 1979).

The magnetic shielding tensors and T^*_2's of ^1H have been determined at room temperature in ZrClH/sub 0.5/, ZrBrH/sub 1.0/, and ZrBrH/sub 0.5/ utilizing multiple pulse NMR. In addition, stoichiometries have been determined by spin counting. Each proton shielding tensor exhibits a large anisotropy compared to those found in hydrocarbons and salts, and is similar to that found in ZrClH/sub 1.0/. Site occupations of the protons in these "sandwichlike" compounds has been inferred from isotropic shifts and from anisotropies.

41294 Magnetic ordering of Gd/sub x/Er/sub 1-x/Rh_4B_4 near the superconducting region. Kohn, S.; Wang, R.H.; Smith, J.L.; Huang, C.Y. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Appl. Phys.;* **50**: No. B3, 1862-1864(1 Mar 1979).

Gd/sub x/Er/sub 1-x/Rh_4B_4 exhibits superconductivity at some critical temperature T/sub c/ followed by the onset of long-range ferromagnetic ordering at a lower temperature and a loss of superconductivity for x<x/sub c/≅0.28, where x/sub c/ is the critical concentration at which superconductivity is suppressed. For x above x/sub c/, the compound is no longer superconducting but is still magnetically ordered. We have made ac resistivity R, ac magnetic susceptibility chi, and dc magnetization measurements on samples with x near x/sub c/. For x≅0.28, the salient features for the R and chi measurements are: (1) In zero external field a sharp maximum in the ac chi (T) and a minimum in R(T) are observed. With a small external dc magnetic field (~10^2 Oe), the extrema in chi (T) and R(T) are depressed and smeared considerably with a corresponding shift in the temperature at which the extrema occur. (2) The sample is not superconducting down to 0.6 K. (3) In the presence of a dc magnetic field, a second ac chi peak appears at a slightly higher temperature. (4) The field dependence of the ac susceptibility resembles that of a spin glass. Details of the field dependence of these observations and the nature of these phenomena will be presented.

41295 ESR evidence of octahedral site occupation in ScH/sub x/:Er . Venturini, E.L. (Sandia Laboratories, Albuquerque, New Mexico 87185). *J. Appl. Phys.;* **50**: No. B3, 2053-2055(1 Mar 1979).

The Er^{3+} electron spin resonance spectrum at low temperatures in powdered Sc/sub .9988/Er/sub .0012/H/sub 1.91/ contains a Γ_7 doublet and associated hyperfine components with cubic site symmetry plus four additional resonances arising from two distinct transitions with axial site symmetry. The axial lines are attributed to octahedral site occupation by protons in the vicinity of some Er^{3+} impurities. The two axial transitions may be associated with two different types of distortions of the Γ_7 wave functions or possibly a Γ_8/sup(1) quartet ground state.

41296 Low temperature magnetic properties of the hydrides and deuterides of Er(Fe/sub 1-x/Mn/sub x/)$_2$. Sankar, S.G.; Gualtieri, D.M.; Wallace, W.E. (Univ. of Pittsburgh, PA). pp 69-74 of Rare earths in modern science and technology. McCarthy, G.J.; Rhyne, J.J. (eds.). New York, NY; Plenum Press (1978).

From 13. rare earth research conference; Olgebay Park, WV, USA (16 Oct 1977).

Er(Fe/sub 1-x/Mn/sub x/)$_2$ crystallizes in the cubic Laves phase structure for compositions up to x = 0.5. These compounds absorb large amounts of hydrogen and deuterium forming stable hydrides and deuterides. Addition of manganese to $ErFe_2$ results in an increase in the amount of hydrogen or deuterium absorbed. X-ray diffraction results of the hydrides and deuterides show a considerable expansion of the lattice. Magnetization measurements of the hydrides and deuterides were performed in the temperature range 4.2 to 300°K and in external fields up to 20 kOe. It is found that the magnetic properties of the hydrides and deuterides examined in this study are, in general, similar. The ferrimagnetic ordering of the unhydrided material is not altered upon the addition of hydrogen or deuterium; however, the strength of the magnetic interaction is considerably weakened as indicated by the reduction of the Curie temperatures. The compensation temperatures of the hydrides and deuterides are lower than the corresponding parent materials. Anisotropy effects observed in some unhydrided ternaries appear to be destroyed by the presence of hydrogen or deuterium.

41297 Ceramic microstructures '76: with emphasis on energy related applications. Fulrath, R.M.; Pask, J.A. (eds.). Boulder, CO; Westview Press (1977). 935p. (CONF-760856—).

From 6. international symposium - ceramic microstructures '76; Berkeley, CA, USA (24 Aug 1976).

Separate abstracts were prepared for items in scope for the energy data base. (FS)

41298 Influence of powder properties on the dimensional stability of UO_2 pellets. Radford, K.C.; Pope, J.M.; Fleischer, L.R. (Westinghouse Research Labs., Pittsburgh, PA). pp 208-222 of Ceramic microstructures '76: with emphasis on energy related applications. Fulrath, R.M.; Pask, J.A. (eds.). Boulder, CO; Westview Press (1977).

From 6. international symposium - ceramic microstructures '76; Berkeley, CA, USA (24 Aug 1976).

Powder properties and sintering behavior of four UO_2 powders were correlated with sintered pellet microstructure and thermal stability. The crystallite and aggregate structure of the powder strongly influenced densification, and the susceptibility for continued densification varied inversely with powder activity and pellet grain size, and directly with the pellet porosity content.

41299 Interdependence of composition, processing parameters, final properties and microstructure of hot pressed SiC. Broussaud, D.; Dumas, J.P.; Lazennec, Y. (General Electric Labs., Marcoussis, France). pp 679-688 of Ceramic microstructures '76: with emphasis on energy related applications. Fulrath, R.M.; Pask, J.A. (eds.). Boulder, CO; Westview Press (1977).

From 6. international symposium - ceramic microstructures '76; Berkeley, CA, USA (24 Aug 1976).

Optimization of hot pressing of β—SiC with B_4C addition has allowed relationships to be established, between processing parameters and characteristics of hot pressed bodies. Microstructural examinations showed evidence of exaggerated grain growth, and factors influencing this were studied. SiC powders with varying α-phase content were hot pressed and the resulting microstructures are

presented. Additional work utilizing additives other than B_4C is also reported.

41300 Thermal diffusivities of microcracked polycrystalline ceramics. Siebeneck, H.J. (Lehigh Univ., Bethlehem, PA); Cleveland, J.J.; Hasselman, D.P.H.; Bradt, R.C. pp 753-762 of Ceramic microstructures '76: with emphasis on energy related applications. Fulrath, R.M.; Pask, J.A. (eds.). Boulder, CO; Westview Press (1977).

From 6. international symposium - ceramic microstructures '76; Berkeley, CA, USA (24 Aug 1976).

The effects of microcracking on the thermal diffusivities of several polycrystalline ceramics are examined. Results are explained on the basis of healing and reopening of microcracks; however, concern for the equilibrium microcrack structure is expressed. Advantages for thermal shock applications are discussed.

41301 Recent developments in deformation mechanism maps for ceramics. Mohamed, F.A.; Langdon, T.G. (Univ. of Southern California, Los Angeles, CA). pp 763-773 of Ceramic microstructures '76: with emphasis on energy related applications. Fulrath, R.M.; Pask, J.A. (eds.). Boulder, CO; Westview Press (1977).

From 6. international symposium - ceramic microstructures '76; Berkeley, CA, USA (24 Aug 1976).

The principles of deformation mechanism mapping techniques are described, and examples are presented of three different types of maps. Important effects occur when the anions and cations diffuse along different paths. This situation is illustrated with maps for Al_2O_3.

41302 Effects of glassy grain boundary phases on the transient creep behavior of UO_2. Clink, L.J.; Solomon, A.A. (Purdue Univ., West Lafayette, IN). pp 849-859 of Ceramic microstructures '76: with emphasis on energy related applications. Fulrath, R.M.; Pask, J.A. (eds.). Boulder, CO; Westview Press (1977).

From 6. international symposium - ceramic microstructures '76; Berkeley, CA, USA (24 Aug 1976).

Instantaneous strain and creep recovery experiments have been conducted on stoichiometric, polycrystalline UO_2 helical spring specimens. The instantaneous strains are found to be independent of total specimen strain and, for low density specimens (~ 88%), can be twice the elastic strains but are smaller for higher density specimens. The recovered strain transients are characterized by a relaxation time that eventually saturates with strain and a relaxation strength that depends on stress and strain and is equal to twice the elastic strains. The actuation energy for the relaxation is 63 +- 12 Kcal/mole. The relaxation appears to result from grain boundary sliding controlled by glassy grain boundary phases.

41303 Effects of ceramic microstructure on strength and fracture surface energy. Bansal, G.K. (Battelle Labs., Columbus, OH). pp 860-871 of Ceramic microstructures '76: with emphasis on energy related applications. Fulrath, R.M.; Pask, J.A. (eds.). Boulder, CO; Westview Press (1977).

From 6. international symposium - ceramic microstructures '76; Berkeley, CA, USA (24 Aug 1976).

Room-temperature strengths, fracture surface energies, and critical flaw depths were independently measured for four single-phase polycrystalline ceramics, and were correlated using Griffith's fracture equation. Effects of microstructure on these parameters were studied using scanning electron fractography. Materials having elongated or plate-like grain structure were found to be both strong and tough. Fracture surface energies differed by a factor of two depending on microstructural features in the direction of crack propagation. Grain-boundary stresses caused by anisotropic thermal expansion of grains affected the strength-flaw severity relation in an interpretable manner.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 40072, 40084, 40360, 41290, 41291, 41292, 41301, 41302, 41303, 41447

41304 Fracture of Si_3N_4 and SiC. Freiman, S.W.; Williams, A.; Mecholsky, J.J.; Rice, R.W. (Naval Research Lab., Washington, DC). pp 824-834 of Ceramic microstructures '76: with emphasis on energy related applications. Fulrath, R.M.; Pask, J.A. (eds.). Boulder, CO; Westview Press (1977).

From 6. international symposium - ceramic microstructures '76; Berkeley, CA, USA (24 Aug 1976).

Measured fracture energies of dense SiC are shown independent of processing while those for hot pressed Si_3N_4 vary from 26 to >100 J/m^2. Strengths of Si_3N_4 do not follow the same trend. Results of measurements on as-received and oxidized material are discussed on the basis of fracture surface analysis.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 41123, 41206, 41300, 41328

41305 (SAND—79-0249) Heat capacity and thermal diffusivity of ScD/sub x/ and ErD/sub x/. Moss, M. (Sandia Labs., Albuquerque, NM (USA)). Apr 1979. Contract EY-76-C-04-0789. 25p. Dep. NTIS, PC A02/MF A01.

The heat capacity, C/sub p/ (T = 298-1000 K), and the thermal diffusivity, α(T = 623-773 K), of ScD/sub x/ and ErD/sub x/ (x = 0-1.83) have been measured. C/sub p/ of ScD/sub x/ increases with x for x = 0-1.59 over the entire temperature range, but then declines for x = 1.83. ErD/sub x/ shows a monotonic increase of C/sub p/ with x, and exhibits a sharp positive anomaly at 910 K for x = 1.82. Both materials display an excess heat capacity which is attributed to disorder in the deuterium sublattice. A minimum in α is observed for ScD/sub x/ and ErD/sub x/ at mid-range values of x where disorder is greatest; α for all samples is fairly constant with T in this limited temperature range.

41306 Kinetics of Fe^{3+} oxidation and Fe^{3+} reduction in MgO single crystals. Sonder, E.; Stratton, T.G.; Weeks, R.A. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Chem. Phys.;* **70**: No. 10, 4603-4608(15 May 1979).

Electron paramagnetic resonance measurements have been used to determine the rate of change of the Fe^{3+} concentration in MgO:Fe crystals due to reduction and oxidation with ambient gases at temperatures between 1000 and 1500 K. The results indicate that diffusion of vacancies with an activation energy of 3.23 eV is the rate-limiting step. There is some evidence that when a diffusion coefficient is obtained from a concentration profile, a contribution due to anomalously high mobility (presumably along dislocations) can be detected.

41307 Observation of the nuclear acoustic resonance of hydrogen in NbH/sub 0.026/. Ringermacher, H.I.; Norberg, R.E.; Sundfors, R.K.; Westlake, D.G. (Department of Physics, Washington University, St. Louis, Missouri 63130). *Phys. Rev. Lett.;* **42**: No. 14, 910-912(2 Apr 1979).

Nuclear acoustic resonance of interstitial solute hydrogen has been observed in a single crystal of the transition metal niobium at 300 K and 49 kG. The resonance line has a demagnetization-dominated width of 0.4 G and a negative Knight shift of (8 +- 4) ppm.

41308 Specific-heat anomalies at the lower critical temperature in reentrant ferromagnetic superconductors. MacKay, H.B.; Woolf, L.D.; Maple, M.B.; Johnson, D.C. (Institute for Pure and Applied Physical Sciences, University of California, San Diego, La Jolla, California 92093). *Phys. Rev. Lett.;* **42**: No. 14, 918-921(2 Apr 1979).

A spike-shaped heat-capacity anomaly has been identified at the lower superconducting-to-normal transition temperature T/sub c/2 of the magnetic superconducting system (Er/sub 1-x/Ho/sub x/)Rh_4B_4. This anomaly can be distinguished from the feature due to long-range magnetic ordering and indicates that the transition at T/sub c/2 is thermodynamically of first order.

41309 Theoretical studies of electronic states produced by hydrogenation of amorphous silicon. Ching, W.Y.; Lam, D.J.; Lin, C.C. (Department of Physics, University of Missouri—Kansas City, Kansas City, Missouri 64110). *Phys. Rev. Lett.;* **42**: No. 12, 805-808(19 Mar 1979).

First-principles calculations of electronic energies of hydrogenated amorphous silicon have been performed for a series of realistic structural models in which hydrogen appears as SiH, SiH_2, SiH_3, $(SiH_2)_n$, and SiHHSi (a broken Si-Si with two H atoms). Whereas all these models are consistent with photoemission experiment (less so for SiH_3), only the last two are found to give band-gap states. The broken-band model is in good agreement with several sets of experiments.

41310 X-ray photoemission spectroscopy study of zirconium hydride. Veal, B.W.; Lam, D.J.; Westlake, D.G. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., Sect. B. Condens. Matter;* **19**: No. 6, 2856-2863(15 Mar 1979).

X-ray photoemission spectroscopy (XPS) measurements are reported for ZrH/sub 1.65/ and Zr metal. The valence-band measurements are compared with available band-theory density-of-states calculations for the metal and hydride. The hydride spectrum differs significantly from the metal spectrum. Most important, a strong peak associated with hydrogen s electrons appears approximately 7 eV below the Fermi level. XPS measurements of Zr 4p core levels show a binding-energy shift of 1 eV between Zr metal and ZrH/sub 1.65/. It is argued that this shift results from charge readjustment in the vicinity of the Zr site. With the addition of hydrogen, net charge must be transferred from the Zr site to the hydrogen site. A charge-density analysis based on simplified cluster calculations is presented.

41311 Magnetic properties of dihydrides and dideuterides of Er and Ho . Friedt, J.M.; Suits, B.; Shenoy, G.K.; Dunlap, B.D.; Westlake, D.G. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Appl. Phys.;* **50**: No. B3, 2049-2050(1 Mar 1979).

The results of low-temperature Moessbauer measurements on the dihydrides and dideuterides of Er and Ho are presented in the range 1.5—10 K. The magnetic ordering temperatures observed from the onset of magnetic hyperfine splitting are in agreement with the specific heat measurements. The saturation hyperfine magnetic field at ^{166}Er in ErH_3 and ErD_3 show the ground crystalline-field level to be Γ_8, while it is difficult to decide between Γ_8 or Γ_7 as the ground state for the Er atom in HoH_3 and HoD_3. The measurements indicate the presence of short-range magnetic order in all the cases. Furthermore, the temperature range over which the short-range magnetic order is observed is intimately related to the stoichiometry of the hydrides or the deutrides.

41312 Magnetic properties of $DyFe_2H_2$ from ^{57}Fe, ^{161}Dy Moessbauer effect and magnetization measurements. Viccaro, P.J.; Friedt, J.M.; Niarchos, D.; Dunlap, B.D.; Shenoy, G.K.; Aldred, A.T.; Westlake, D.G. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Appl. Phys.;* **50**: No. B3, 2051-2052(1 Mar 1979).

A single phase stable hydride with nominal composition $DyFe_2H_2$ is shown to have the cubic C15 Laves structure with a 5% larger lattice constant. ^{57}Fe Moessbauer spectra show two sites with nearly equal population and with different isomer shifts and hyperfine fields. Based on the average hyperfine field at 4.2 K, an Fe moment of approximately 1.6 μ/sub B/ is estimated. From the ^{161}Dy data at 4.2 K, which show a single site, a nearly free-ion moment of 9.8 μ/sub B/ is determined. Relaxation effects in the ^{161}Dy spectra above 77 K, combined with a sharp decrease in the moment with increasing temperature, imply a weakening of the Dy-Fe magnetic coupling induced by the presence of the hydrogen.

41313 Magnetic anomaly in superconducting $TmRh_4B_4$. Smith, J.L.; Huang, C.Y.; Tsou, J.J.; Ho, J.C. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Appl. Phys.;* **50**: No. B3, 2330-2332(1 Mar 1979).

We have investigated the magnetic and superconducting properties of $TmRh_4B_4$ (which becomes superconducting at 9.6 K) by means of ac and dc magnetic susceptibility and specific heat measurements. At 10.7 K, an ac susceptibility peak similar to those found in spin glasses has been observed. In addition, a pronounced specific heat peak has been observed at 11.4 K. The susceptibility peak is essentially unaffected by substitution of 1% Lu or Er for the Tm, but it diminishes when much larger amounts of Er are substituted. The physical origin of this anomalous peak will be discussed.

41314 Influence of hybridization on the superconducting properties of PdH. Morozov, A.I. (Physicotechnical Institute, Moscow). *Sov. Phys. - Solid State (Engl. Transl.);* **20**: No. 11, 1918-1922(Nov 1978).

An analysis is made of the influence of the electron—phonon interaction on the energy band structure of PdH. An increase in the hybridization parameter associated with a change in the band structure due to deuteration of this compound reduces the electron—phonon interaction constant. The reverse isotopic effect in the PdH—PdD system and properties of ternary palladium—noble metal—hydrogen compounds are explained.

41315 Auger electron spectrum of zirconium carbide. Matskevich, T.L.; Kazantsev, A.P. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Phys. - Solid State (Engl. Transl.);* **20**: No. 11, 1942-1945(Nov 1978).

A nondifferentiated spectrum of the Auger electrons was obtained for an outgassed compacted sample of ZrC. The intensity of the Auger transitions associated with the ionization of the M_5 level of Zr and involving the valence electrons was less than the intensity of the transitions without the valence electrons. The Auger peak of carbon in ZrC had a characteristic toothed profile. This profile was deduced from a histogram of the density of occupied states. It was found that the positions of the maxima on the energy scale and the ratio of their intensities in the Auger peak of carbon could be explained by the characteristics of the density of occupied states in ZrC. The results indicated that, to within +- 5%, the surface of ZrC was stoichiometric after heating in vacuum for 8 h at 2300°K.

41316 Superconductivity and phonon softening in the palladium—hydrogen system. Postnikov, V.S.; Postnikov, V.V.; Fedorov, V.M. (Polytechnic Institute, Vorenezh). *Sov. Phys. - Solid State (Engl. Transl.);* **20**: No. 11, 1987-1988(Nov 1978).

An expression is obtained for the constant of the interaction between electrons and optical phonons in the Pd—H system and allowance is made for the softening of phonon states. The influence of replacement of hydrogen with deuterium is considered. The results are related to the superconductivity of the system.(AIP)

41317 Magnetic properties of Ce/sub x/Eu/sub 1-x/B_6 solid solutions. Aivazov, M.I.; Aleksandrovich, S.V.; Mkrtchyan, V.S. *Sov. Phys. - Solid State (Engl. Transl.);* **20**: No. 11, 1990-1991(Nov 1978).

The magnetic susceptibility was determined by the Faraday magnetic balance method in fields of 3, 5, and 10 kOe in the temperature range 80—1000°K. The results were used to determine the effective magnetic moment and the Weiss temperature as a function of the composition. The results were in agreement with the RKKY theory of indirect exchange via the conduction electrons.(AIP)

41318 Superconductivity of the BaPb/sub 1-x/Bi/sub x/O_3 oxide system. Protasov, E.A.; Zaitsev-Zotov, S.V.; Venevtsev, Y.N.; Bogatko, V.V. (Engineering-Physics Institute, Moscow). *Sov. Phys. - Solid State (Engl. Transl.);* **20**: No. 11, 2028-2029(Nov 1978).

The transition temperatures to the superconducting state and the critical magnetic fields were determined as a function of the composition. The following values of the transition temperature were obtained: T/sub c/=10.8 +- 0.3°C for x=0.2 and T/sub c/=10.5—12.5 +- +- 0.3°K for x=0.3. The dependence of the resistance of a sample with x=0.3 on the magnetic field was somewhat unusual; it was explained by assuming that the sample was a semimetal. (AIP)

41319 Thermionic-emission and adsorption properties of a eutectic alloy of zirconium carbide and tungsten. Matskevich, T.L.; Vil'k, Y.N. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **23**: No. 10, 1218-1221(Oct 1978).

As the temperature is raised from 1200 to 2900 °K, the work function and the spectral emissivity of the alloy ZrC—W 75 wt. % vary from 3.54 eV to 4.38 eV and from 0.6 to 0.43, respectively. The surfaces of samples of this composition have a slight contrast in work function up to 2400 °K. The surface consists of a layer of zirconium and carbon adatoms on tungsten. Above 2400 °K this layer is significantly thinner, it vanishes at 2900 °K. A macroscopic redistribution of the metal component in the alloy occurs because of heterodiffusion and the difference in the evaporation rates of the components. In the temperature range 1200—2200 °K, it is possible to vary phi by several tenths of an electron volt by changing the residual gas composition. Increasing the hydrogen pressure from 10^{-9} to 10^{-2} torr does not change the work function in the temperature range 1300—2450 °K. The initial sticking factors of hydrogen and ($CO+N_2$) on the alloy at 300 and 1300 °K are, respectively, (4 +- 2) $x10^{-3}$ and 10^{-5} for hydrogen and (3 +- 2) $x10^{-2}$ and (6 +- 3) $x10^{-3}$ for ($CO+N_2$). These values are much lower for the alloy than for its components. The total adsorption coating by hydrogen, N/sub ad/, at 300 °K is roughly equal to N/sub ad/(ZrC). At 300 °K the rate of hydrogen dissolution in ZrC—W 75 wt. % is lower than in ZrC—Re 50 wt. %.

41320 Spectra of Nd_2O_3 and $Nd_2Ti_2O_7$ single crystals. Pevtsov, A.B.; Shadrin, E.B.; Il'inskii, A.V.; Kartenko, N.F.; Melekh, B.T.; Andreev, A.A. *Sov. Tech. Phys. Lett. (Engl. Transl.);* **4**: No. 9, 425-426(Sep 1978).

Spectroscopic experiments and a study of the conditions for the synthesis of neodymium oxide and neodymium dititanate single crystals are reported. These studies include transmission and luminescence spectra at room and liquid-nitrogen temperatures.(AIP)

41321 Performance characteristics of the HYCSOS chemical heat pump system based on rare earth transition metal AB_5 hydrides. Sheft, I.; Gruen, D.M.; Lamich, G.J.; Carlson, L.W.; Knox, A.E.; Nixon, J.M.; Mendelsohn, M.H. (Argonne National Lab., IL). pp 17-24 of Rare earths in modern science and technology. McCarthy, G.J.; Rhyne, J.J. (eds.). New York, NY; Plenum Press (1978). From 13. rare earth research conference; Olgebay Park, WV, USA (16 Oct 1977).

The Argonne HYCSOS system is a chemical heat pump based on rare earth-transition metal AB_5 hydrides that functions in heating, cooling, and energy conversion modes. Hydrogen gas is transferred from one hydride bed by thermal energy input at a characteristic temperature to a second bed where hydrogen is absorbed and thermal energy is released at another characteristic temperature. The two materials used in the present system are $LaNi_5$ and $CaNi_5$. The demonstration unit has four hydride containing steel tanks of three liter capacity each with internal heat transfer tubing. Three fluid heat transfer loops which can be remotely valved and fluid pumped into the appropriate tank are available. The thermal energy input, solar or other suitable low temperature heat, is simulated by an 18 KW electric heater. A 25 KW water cooled heat exchanger is used for heat rejection. Hydrogen and heat transfer fluid flows and temperature and heater and pump power are measured and recorded on a data logger. Important data are visually displayed on analog readout meters on a graphic panel. For safety considerations, the hydrogen containing subassembly is contained in an enclosed hood provided with continuous hydrogen concentration monitoring. The unit is of sufficient size that thermal losses are small compared to measured heat transfer rates in a heat storage mode, refrigeration mode and power generation mode. Experimental data will be compared with predicted performance.

41322 Hydrogen absorption in ternary substituted AB_5 alloys with particular reference to La_1—/sub x/Y/sub x/Ni_5 and $LaNi_5$—/sub x/Al/sub x/ alloys. Mendelsohn, M.H.; Gruen, D.M.; Dwight, A.E. (Argonne National Lab., IL). pp 25-30 of Rare earths in modern science and technology. McCarthy, G.J.; Rhyne, J.J. (eds.). New York, NY; Plenum Press (1978).

From 13. rare earth research conference; Olgebay Park, WV, USA (16 Oct 1977).

The utility of $LaNi_5$ as a storage material for hydrogen derives from its large hydrogen capacity and its ability to absorb and desorb hydrogen rapidly at relatively low pressures near room temperature. $LaNi_5$ crystallizes with the hexagonal $CaCu_5$ type structure, from which ternary alloys may be prepared by substitution of various elements on either the La or Ni sites. Alloys of composition $LaNi_5$—/sub x/Al/sub x/ (x = 0.2 to 1.5) have been prepared and the desorption characteristics of the corresponding hydrides investigated at several temperatures. Desorption isotherms at room temperature have been determined for the alloys La_1—/sub x/Y/sub x/Ni_5, where x = 0.3 to 0.5. Brief investigations on other substituted $LaNi_5$ and YNi_5 alloys have also been conducted. Results of these studies indicate that Al substitutions greatly reduce the plateau pressures of $LaNi_5$ without impairing its kinetics or hydrogen carrying capacity. We have found that the present desorption measurements reasonably agree with a previously observed correlation between desorption pressures and alloy cell volumes. Finally, preliminary evidence suggests that AB_5 alloys which do not possess the $CaCu_5$ type structure may not absorb appreciable amounts of hydrogen at pressures below 70 atm.

41323 Solar furnace experiments for thermophysical properties studies of rare-earth oxide MHD materials. Coutures, J.P. (Centre National Recherche Scientifique, Montlouis, France). pp 31-44 of Rare earths in modern science and technology. McCarthy, G.J.; Rhyne, J.J. (eds.). New York, NY; Plenum Press (1978).

From 13. rare earth research conference; Olgebay Park, WV, USA (16 Oct 1977).

Some high temperature work performed with solar furnaces on rare earth oxides is reviewed. Emphasis is on the thermophysical properties (refractoriness, vaporization behavior) and the nature of solid solution on materials which could be used as electrodes for the MHD process. As new sources of energy are being developed due to the world energy crisis, MHD conversion could be useful. The development of MHD systems requires new efforts to develop and optimize materials properties. These materials must have good mechanical and electrical properties (if possible, pure electronic conduction with good emission). Because of the high temperature in MHD generators, the materials for electrodes must have good refractoriness and also must resist vaporization and corrosion at high temperature (T ~ 2000°C). Rare-earth oxides are the basic components for most of the MHD electrode materials and it is important to know their thermophysical properties (solidification point phase transitions, heat of fusion and of phase transition, vapor pressure). Because of the high temperature range and the nature of the atmosphere in which these experiments must be performed, special equipment adapted to solar furnaces was developed.

41324 Rare earth ceramics for MHD-power generators. Frederikse, H.P.R.; Hosler, W.R.; Negas, T. (National Bureau of Standards, Washington, DC). pp 45-53 of Rare earths in modern science and technology. McCarthy, G.J.; Rhyne, J.J. (eds.). New York, NY; Plenum Press (1978).

From 13. rare earth research conference; Olgebay Park, WV, USA (16 Oct 1977).

The hot-wall type of open-cycle MHD power generators requires electrode materials that are able to operate at temperatures up to 1800°C in a highly corrosive atmosphere and under severe electrical and thermal current conditions. Several compounds containing rare-earth elements, in particular, $LaCrO_3$ and CeO_2 with additions of other oxides, have shown to be promising candidates for this application. This paper describes the materials requirements including their physical, chemical and structural properties. Results of evaluation experiments performed on $LaCrO_3$- and ceria-based electrodes are discussed.

41325 Influence of composition and cation stoichiometry on the volatility, electrical conductivity and thermal expansion of $LaCrO_3$ based oxides. Anderson, H.U. (Univ. of Missouri, Rolla); Murphy, R.; Humphrey, K.; Rossing, B.; Aldred, A.; Procarione, W.L.; Ackermann, R.J.; Bates, J.L. pp 55-61 of Rare earths in modern science and technology. McCarthy, G.J.; Rhyne, J.J. (eds.). New York, NY; Plenum Press (1978).

From 13. rare earth research conference; Olgebay Park, WV, USA (16 Oct 1977).

Current research is directed towards the understanding of the role that chemical composition and cation stoichiometry have on the volatilization, electrical conductivity, and thermal expansion properties of $LaCrO_3$ and $LaCrO_3$-based compositions. The objective of the investigation is to develop oxides that have properties that make them suitable for long-term operation as electrodes in open-cycle, hot-wall environment. It is possible to alter the above properties of the nominal compositions containing Al and Mg by variations in Al content and in the cation stoichiometry. Thermal expansion, electrical conductivity, volatilization rate, lattice parameter and thermal conductivity data are reported for the range of x = 0 to 1 and -.2 ≦ y ≦ .1.

41326 MHD electrode-insulator micro- and macro-structure. Bates, J.L. (Battelle-Northwest Labs., Richland, WA); Rossing, B.R.; Bowen, H.K. pp 731-752 of Ceramic microstructures '76: with emphasis on energy related applications. Fulrath, R.M.; Pask, J.A. (eds.). Boulder, CO; Westview Press (1977).

From 6. international symposium - ceramic microstructures '76; Berkeley, CA, USA (24 Aug 1976).

The development of MHD electrode modules for coal-fired and for clean fuel fired MHD channels has required the development of compatible materials for high current flux electrical conductors, high temperature insulators and current lead-outs. Large thermal gradients due to high fluxes (50 to 200 watts/cm²), potassium seed condensation and subsequent reaction, and slag-seed interactions with the materials causes restructuring of the micro- and macrostructure. Results from current modules based on ZrO_2—CeO_2 and spinel (e.g., $FeAl_2O_4$—Fe_3O_4) electrodes; MgO, Al_2O_3, and $MgAl_2O_4$ insulators; and platinum or steel current-leadouts are discussed.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 40097, 41124, 41266

41327 (UCRL—17899(Rev.1)) **Materials development and evaluation for the ceramic helical expander.** Landingham, R.L.; Taylor, R.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Feb 1979. Contract W-7405-ENG-48. 59p. Dep. NTIS, PC A04/MF A01.

The supporting role of the materials program for the ceramic helical expander program is described. The materials problems for this rotory expander in an extremely severe environment - a direct coal-fired Brayton topping cycle is defined. Readily available materials and methods are evaluated for possible solution to these material problems as well as initiating some longer-range studies to improve reliability. A preliminary screening of materials in hot coal-fired environments to select candidate materials and coating, was made, but there is a need to perform more detailed evaluations of these candidate materials-reaction-bonded silicon nitride (RBSN) and Si—Al—O—N (Sialon) system- and coatings-chemical-vapor-deposited silicon nitride (CVD-Si_3N_4) and CVD-Sialon. Termination of the helical expander program abruptly stopped the materials program during this evaluation.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 40823

41328 Association of the 6-eV optical band in sapphire with oxygen vacancies. Evans, B.D. (Naval Research Lab., Washington, DC); Hendricks, H.D.; Bazzarre, F.D.; Bunch, J.M. pp 265-274 of Ion implantation in semiconductors, 1976. Chernow, F.; Borders, J.A.; Brice, D.K. (eds.). New York, NY; Plenum Press (1977).

From Proceedings of V international conference on ion implantation in semiconductors and other materials; Boulder, CO, USA (9 Aug 1976).

There is a characteristic 3.8-eV photoemission band associated with the particle-irradiation-induced coloration bands at 4.8, 5.4, and 6.0 eV in crystalline sapphire. Furthermore, excess aluminum has a strong influence in stabilizing the optically active lattice damage produced by energetic particles. The fact that excess anions produced by oxygen implantation do not result in uv absorption or emission bands suggests that these bands are to be associated with anion vacancies.

41329 Influence of UO_2 fuel pellet microstructure on irradiation induced densification. Hart, P.E.; Daniel, J.L. (Battelle, Pacific Northwest Labs., Richland, WA). pp 710-720 of Ceramic microstructures '76: with emphasis on energy related applications. Fulrath, R.M.; Pask, J.A. (eds.). Boulder, CO; Westview Press (1977).

From 6. international symposium - ceramic microstructures '76; Berkeley, CA, USA (24 Aug 1976).

Sintered UO_2 fuel pellets with specific ranges of microstructural features were demonstrated to be stable toward densification during irradiation. For example, fuel pellets with initial densities as low as 91% TD characterized by structures with a medium pore diameter greater than 1 μm and grain sizes greater than 10 μm were found not to densify. These stable microstructures were developed by the use of appropriate fabrication techniques.

41330 Summarization of experimental results on the radiation creep of ceramic fuel materials on the basis of a material burn-off model at thermal peak volume. Golovnin, I.S.; Bibilashvili, Yu.K.; Malgyin, V.V.; Naboichenko, K.V. pp 93-102 of Radiatsionnye effekty izmeneniya mekhanicheskikh svoisty konstruktsionnykh materialov i metody ikh issledovaniya. Pisarenko, G.S. (ed.). Kiev, USSR; Izdatel'stvo Naukova Dumka (1977). (In Russian)

From 2. All-Union conference on the radiation effects of the change in the mechanical properties of construction materials and methods of investigating them; Kiev, USSR (Apr 1976).

A model is proposed for radiation creep of ceramic fuel materials, based on material burn-off at thermal peak volume. A summarization is made of known experimental results on radiation creep of ceramic fuel, and relationships are proposed for the computation of non-steady radiation creep. Its relationship outside the field of reactor irradiation to temperature, stress, and time is studied. 12 references, 7 figures, 1 table.

41331 Low-temperature radiation creep of uranium dioxide. Arlamenkov, N.I.; Bogatov, A.N.; Malygin, V.B.; Men'shikova, T.S.; Miiloserdin, Yu.V.; Naboichenko, K.V. pp 103-107 of Radiatsionnye effekty izmeneniya mekhanicheskikh svoisty konstruktsionnykh materialov i metody ikh issledovaniya. Pisarenko, G.S. (ed.). Kiev, USSR; Izdatel'stvo Naukova Dumka (1977). (In Russian)

From 2. All-Union conference on the radiation effects of the change in the mechanical properties of construction materials and methods of investigating them; Kiev, USSR (Apr 1976).

An examination is made of the design of equipment for studying radiation creep of ceramic nuclear fuel. Results are given for studies of uranium dioxide creep in the temperature range of 300 to 900°C at fission densities of (2 to 8) x 10^{72} fissions/cm^3sec. 3 references, 5 figures, 1 table.

41332 Kinetics of carbide and boride breakdown in neutron irradiation. Ogorodnikov, V.V.; Murzin, L.M.; Krainii, A.G. pp 116-119 of Radiatsionnye effekty izmeneniya mekhanicheskikh svoisty konstruktsionnykh materialov i metody ikh issledovaniya. Pisarenko, G.S. (ed.). Kiev, USSR; Izdatel'stvo Naukova Dumka (1977). (In Russian)

From 2. All-Union conference on the radiation effects of the change in the mechanical properties of construction materials and methods of investigating them; Kiev, USSR (Apr 1976).

Results are given for the study of the kinetics of the electroresistance of diborides of titanium, zirconium, and titanium carbides in neutron irradiation at various temperatures of irradiation. An increase in the irradiation temperature was shown to lead to an increase in radiation stability: The nature of the curve of electroresistance change changes from a spasmodic to even pattern as it passes through the irradiation temperature of 400°C which indicates a change in the accumulation mechanism of internal stresses and the development of breakdown in the samples. 5 references, 2 figures, 1 table.

COMPOSITE MATERIALS

PREPARATION AND FABRICATION

41333 (Y/DA—8065) **High-temperature thermal insulation.** Brassell, G.W.; Wai, G.C. (Oak Ridge Y-12 Plant, TN (USA); Oak Ridge National Lab., TN (USA)). 23 Feb 1979. Contract W-7405-ENG-26. 4p. (CONF-790625—1). Dep. NTIS, PC A02/MF A01.

From 14. carbon conference; University Park, PA, USA (25 Jun 1979).

The primary purpose of this study was to determine the effects of: fiber length, fiber diameter, fiber concentration, fiber to binder ratio and carbonization temperature on composite density, compressive strength, thermal conductivity and outgassing. Fiber materials investigated consisted of rayon and polyacrylonitrile (PAN) precursors, with the precursor material carbonized at 1350°C prior to using.

STRUCTURE AND PHASE STUDIES

41334 (SAND—79-0158C) **Morphology of rubber modified epoxy encapsulants.** Sayre, J.A. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 12p. (CONF-790518—5). Dep. NTIS, PC A02/MF A01.

From 10. US/UK symposium on neutron generators; Albuquerque, NM, USA (21 May 1979).

Examination of rubber modified epoxy, cured with diethanol amine, via the transmission electron microscope has shown that a broad distribution of rubber particle sizes exists. The average particle size for particles greater than .1 μm was found to be .8 μm. A significant population of particles was found whose diameters are less than .1 μm. Examination of the particle interface showed that the interface between the dispersed phase and the epoxy matrix was sharp within the accuracy of the method used. The morphology observed was compared against morphologies which have been purported to result in toughening via shear banding and crazing. It was found that the observed particle size distribution did not preclude toughening by these mechanisms.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 40114, 41336

41335 Composite-rim flywheels: spin tests. Reedy, E.D. Jr.; Street, H.K. (Sandia Labs., Albuquerque, NM). *SAMPE Q.;* **10**: No. 3, 36-41(Apr 1979).

Two composite-rim flywheels of a size appropriate for use in a hybrid vehicle were designed. Each designed employed a different method of utilizing Kevlar 49/epoxy bands to attach the rim to an aluminum hub. Four prototype flywheels, two of each design, have been fabricated and spin tested.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 41333

41336 (SAND—79-0605c) **Accelerated thermal aging of rubber modified epoxy encapsulants.** Sayre, J.A. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 14p. (CONF-790518—4). Dep. NTIS, PC A02/MF A01.

From 10. US/UK symposium on neutron generators; Albuquerque, NM, USA (21 May 1979).

A program is outlined to enable prediction of physical properties of rubber modified epoxy encapsulants over the life time of the extended life neutron generators. Preliminary results show that the chief aging phenomenon occurring is increased crosslink density of the epoxy matrix. No changes in the rubber phase have been detected. The effect of increased epoxy crosslink density has been higher volume resistivity at 66°C, increased tensile strength, and decreased ultimate elongation.

41337 Critical currents for superconducting composites in the 1000-A regime. Finnemore, D.; Verhoeven, J.D.; Ostenson, J.E.; Gibson, E.D.; Sample, H.H. (Ames Laboratory: USDOE and Department of Physics, Iowa State University, Ames, Iowa 50011). *J. Appl. Phys.;* 50: No. 4, 2867-2870(Apr 1979).

Multifilamentary superconducting composites having Nb_3Sn filament sizes in the 200—2000-A regime have been studied in magnetic fields up to 18 T. The critical currents obey Kramer's scaling laws, and flux pinning at high fields is governed by the flux-line lattice shear modulus C_{66}. Despite the discontinuous nature of the filaments, the flux pinning at the field approaching H/sub c/2 is very similar to the large-diameter continuous filament case. The upper critical field is somewhat lower than bulk Nb_3Sn as expected from the stress imposed by the bronze matrix. With the addition of a few percent Ga, H/sub c/2 can be raised by about 2 T.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 41550

OTHER MATERIALS

41338 Contribution of non-elastic processes to changes in the properties of solid states exposed to the action of high energy electrons and gamma quanta. Zalenskii, V.F.; Stratienko, V.A.; Khorenko, V.K. pp 160-164 of Radiatsionnye effekty izmeneniya mekhanicheskikh svoisty konstruktsionnykh materialov i metody ikh issledovaniya. Pisarenko, G.S. (ed.). Kiev, USSR; Izdatel'stvo Naukova Dumka (1977). (In Russian)

From 2. All-Union conference on the radiation effects of the change in the mechanical properties of construction materials and methods of investigating them; Kiev, USSR (Apr 1976).

An examination is made of the studies of the effect of electrons with energies of E/sub o/ ~ to 100 MeV on the electrophysical properties of semiconductors by accounting for the contribution that is made to defect formation by the interaction between the irradiated samples and changes in the internal energy of nuclides. 9 references, 1 table.

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 40520, 40523, 40524, 40528, 41200, 41204

41339 (COO—4120-3) **Comparative analysis of structural concrete Quality Assurance practices on nine nuclear and three fossil fuel**

power plant construction projects. Final summary report. Willenbrock, J.H.; Thomas, H.R. Jr.; Burati, J.J. Jr. (Pennsylvania State Univ., University Park (USA). Coll. of Engineering). Dec 1978. Contract EY-76-S-02-4120. 241p. Dep. NTIS, PC A11/MF A01.

A summary of two reports, COO/4120-1 and COO/4120-2, is given. A comparative analysis was made of the Quality Assurance practices related to the structural concrete phase on nine nuclear and three fossil fuel power plant projects which are (or have been) under construction in the United States in the past ten years. For the nuclear projects the analysis identified the response of each Quality Assurance program to the applicable criteria of 10 CFR Part 50, Appendix B as well as to the pertinent regulatory requirements and industry standards. For the fossil projects the analysis identified the response of each Quality Assurance program to criteria similar to those which were applicable in the nuclear situation. The major emphasis was placed on the construction aspects of the structural concrete phase of each project. The engineering and design aspects were examined whenever they interfaced with the construction aspects.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 41219, 41357, 41978

41340 X-ray study of the crystallographic transition in hydrogen below 1.5 K. Gates, J.V.; Granfors, P.R.; Fraass, B.A.; Simmons, R.O. (Physics Department and Materials Research Laboratory, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). *Phys. Rev., Sect. B. Condens. Matter;* **19**: No. 7, 3667-3675(1 Apr 1979).

The fcc to hcp and hcp to fcc phase transformations in single crystals of hydrogen have been studied using x-ray diffraction techniques. The transformation temperature T* has been mapped as a function of orthohydrogen concentration chi in the region of $0.17 < T^* < 1.5$ K and $0.48 < chi < 0.7$. The fcc to hcp transformation temperature extrapolates to zero near a concentration of 0.49. The transformation temperatures and widths agree with other experimental results at higher temperatures, but exclude low-concentration NMR data in the literature from being associated with the crystallographic transformation in bulk samples.

41341 Observation of the dynamic behavior of the antiferromagnetic-ferromagnetic phase transition in the one-dimensional spin-1/2 antiferromagnet α-CuNSal . Azevedo, L.J.; Narath, A.; Richards, P.M.; Soos, Z.G. (Sandia Laboratories, Albuquerque, New Mexico 87185). *J. Appl. Phys.;* **50**: No. B3, 1859-1861(1 Mar 1979).

Proton spin lattice relaxation rates in the spin-1/2 Heisenberg antiferromagnet α-CuNSal have been measured in applied fields up to 125 kOe in the temperature range 1—4 K. All inequivalent protons in the unit cell can be identified. The strong coupling of protons close to the antiferromagnetic (AF) chain provides an opportunity to use ^1H spin lattice relaxation rates, T_1^{-1}, to probe the dynamics of the spin system through the antiferromagnetic-ferromagnetic (AF-F) phase transition as the critical field, H/sub c/, is exceeded. The AF-F phase transition is observed at H/sub c/=4J/g/sub e/μ/sub B/(J/k/sub B/=3.04 K) as a strong enhancement of $T^{-1}{}_1$. For fields above H/sub c/, the proton $T^{-1}{}_1$ decreases over 4 orders of magnitude. The effect of increasing temperature is to broaden the peak in $T^{-1}{}_1$, and move it to lower field. The uniform magnetization of the AF spin system, as measured by proton resonance shifts, is in excellent agreement with calculations by Bonner and Fisher. The behavior of the relaxation rate can be understood in terms of the fermion representation.

41342 Magnetic ordering phenomena in TmS. Koehler, W.C.; Moon, R.M.; Holtzberg, F. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Appl. Phys.;* **50**: No. B3, 1975-1977(1 Mar 1979).

Neutron diffraction data have been obtained from powder and single crystal specimens of TmS at temperatures ranging from room temperature to 1.7 K and in applied magnetic fields up to 42.8 kOe. In zero field TmS undergoes a transition, at about 8.9 K, to an antiferromagnetic structure which is almost the type two face-centered cubic structure. In this structure there are four G-type or (π,π,π) type antiferromagnetic sublattices such that the moments are parallel in (111) planes, alternating in sign from one such plane to the next. Superimposed on the ordering is a sinusoidal modulation with propagation vectors parallel to [110] directions. The structure is a multidomain one which gives rise to a very complex diffraction pattern. With polarization analysis it was possible to determine the moment directions in the domains. For example, in domains with propagation vector parallel to [110] the moments are parallel to [112]. From powder data taken at 1.7 K the maximum value of the Tm moment was estimated to be 4.0 μ/sub B/. Diffuse streaks of magnetic origin with temperature and field dependence different from that of the satellites were observed which may influence our estimate of the magnitude of the ordered moment. The response of the magnetic reflections to applied magnetic fields can be understood, in part, in terms of domain repopulation.

41343 Neutron scattering studies of the coexistence of long-range magnetic order and superconductivity in Dy/sub 1.2/Mo_6S_8 and Tb/sub 1.2/Mo_6S_8. Thomlinson, W.; Shirane, G.; Moncton, D.E.; Ishikawa, M.; Fischer, O. (Brookhaven National Laboratory, Upton, New York 11973). *J. Appl. Phys.;* **50**: No. B3, 1981-1983(1 Mar 1979).

Both Dy/sub 1.2/Mo_6S_8 and Tb/sub 1.2/Mo_6S_8 are superconducting below T/sub c/=2.05 K. Neutron scattering studies show that these compounds in zero applied magnetic field develop long-range antiferromagnetic order (greater than 300 A) at T/sub M/=0.4 K and T/sub M/=1.0 K, respectively, which does not destroy the superconducting state. Magnetization measurements at temperatures below T/sub M/ suggest the development of ferromagnetic order as the applied magnetic field increases. In the case of Tb/sub 1.2/Mo_6S_8 the neutron data show long-range ferromagnetic order developing for H> or =H/sub c2/=1.9 kOe where H/sub c2/ is the upper critical field for superconductivity. However, for Dy/sub 1.2/Mo_6S_8 long-range ferromagnetic order begins to develop at H=200 Oe, a field much less than H/sub c2/=1.2 kOe. As the ferromagnetic intensity increases, the antiferromagnetic intensity decreases. Between H=200 Oe and H=1.2 kOe both ferromagnetic and antiferromagnetic order occur with the sample in the superconducting state.

41344 Crystal structures of UCo_9Si_5 and $ZrCo_9Si_5$. Yarmolyuk, Y.P.; Aksel'rud, L.G.; Gladyshevskii, E.I. (L'vov State University). *Sov. Phys. - Crystallogr. (Engl. Transl.);* **23**: No. 5, 531-533(Sep 1978).

The authors have determined the crystal structure of UCo_9Si_5: a=14.85 A, sp. gr. $P6_3/m$, Z=6. All the atoms occupy regular point systems 6(h) $xy^1/_4$, R=0.105 for 380 reflections. The structure of UCo_9Si_5 belongs to the series containing the structural types ZrAlNi(Fe_2P), $Zr_2Fe_{12}P_7$, $Hf_5Co_{19}P_3$, and UNi_9Si_5 and having a common formula M/sub n/2+5nN/sub(n/2+5n)/2 (M is a metal component, N a nonmetal component); it is the term with n=4. The compound $ZrCo_9Si_5$ is isostructural with UCo_9Si_5: a=14.72 A, c=3.624 A.

41345 Low temperature heat capacities of rare earth sesquisulfides. Taher, S.M.A. (Wichita State Univ., KS); Gruber, J.B.; Ho, J.C.; Yeh, D.C. pp 359-365 of Rare earths in modern science and technology. McCarthy, G.J.; Rhyne, J.J. (eds.). New York, NY; Plenum Press (1978).

From 13. rare earth research conference; Olgebay Park, WV, USA (16 Oct 1977).

Heat capacity measurements made between 2 and 20°K are reported for various crystalline samples of rare earth sesquisulfides. Lattice and electronic contributions to heat capacity are assumed to be similar to values measured for La sesquisulfide. Magnetic and Schottky contributions to heat capacity are analyzed with help from an interpretation of optical and magnetic susceptibility data taken on the same or similar samples.

41346 Absorption spectrophotometric and x-ray diffraction evidence for mixed-valence compounds in anhydrous halides of lanthanide—actinide mixtures. Haire, R.G. (Oak Ridge National Lab., TN); Young, J.P.; Peterson, J.R.; Fellows, R.L. pp 501-506 of Rare earths in modern science and technology. McCarthy, G.J.; Rhyne, J.J. (eds.). New York, NY; Plenum Press (1978).

From 13. rare earth research conference; Olgebay Park, WV, USA (16 Oct 1977).

Absorption spectrophotometry and x-ray diffraction have been used to study the anhydrous halides of Cf, Es, and mixtures of these actinides with selected lanthanides. Hydrogen reduction of the above trihalides (Cl, Br, I) can produce either the dihalides or mixtures of dihalides and trihalides. Described here is some recent work on these materials that has provided evidence for the existence of mixed-valence compounds (M_8X_{11}, $M_{11}X_{24}$ or M_6X_{13}, where X = halide ion) containing an actinide element.

PROPERTIES

REFER ALSO TO CITATION(S) 40400, 40530, 40698, 41239, 41345, 41346, 41984

41347 Lattice constants and band-gap variations of the pentenary semiconductor system Cu/sub 1-y/Ag/sub y/InS/sub(2-x/)Se/sub 2x/. Chapman, G.H.; Shewchun, J.; Loferski, J.J.; Garside, B.K.; Beaulieu, R. (Department of Engineering Physics, McMaster University, Hamilton, Ontario, Canada, L8S 4M1). *Appl. Phys. Lett.;* **34**: No. 11, 735-737(1 Jun 1979).

Much interest has been expressed in the ternary IB-III-VI_2 group semiconductors for use in electro-optical devices such as solar cells. Subsets of these, $AgInS_2$, $AgInSe_2$, $CuInS_2$, and $CuInSe_2$, have been combined to form the pentenary alloy system Cu/sub 1-y/Ag/sub y/InS/sub(2-x/)Se/sub 2x/. With such an alloy the band gap may be varied while keeping the lattice constant fixed. Samples were

prepared by reacting stoichiometric powder mixtures at about 900 °C. X-ray diffractometry tests suggest the alloys maintained complete solid solubility throughout the system in a chalcopyrite-type crystal structure. From cathodoluminescence studies on pressed bars of these powders the band-gap energies were estimated at 300 °K. These tests suggest that the alloys are all direct-band-gap semiconductors.

41348 Direct observation of voltage barriers in ZnO varistors. Krivanek, O.L.; Williams, P.; Lin, Y. (Department of Materials Science and Mineral Engineering and the Materials and Molecular Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Appl. Phys. Lett.;* **34**: No. 11, 805-806(1 Jun 1979).

Voltage barriers in a ZnO varistor have been imaged by voltage-contrast scanning electron microscopy. They are due to grain boundaries and are capable of supporting voltage differences of up to about 4 V.

41349 Atomic migration in solid sodium. O'Reilly, D.E. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **70**: No. 10, 4633-4634(15 May 1979).

Vacancy single jump and double jump diffusion and associated coefficients of self-diffusion are calculated for solid sodium using values of the migration and formation energies from both static and dynamic calculations reported in the literature. The calculated preexponential factors for both types of diffusion are in good agreement with the experimental results of Mundy on solid sodium.

41350 Refractive index of LiF films as a function of time. Haltom, T.L.; Arakawa, E.T.; Williams, M.W.; Kretschmann, E. (Oak Ridge National Laboratory, Health Safety Research Division, Oak Ridge, Tennessee 37830). *Appl. Opt.;* **18**: No. 8, 1233-1236(15 Apr 1979).

The optical properties and thickness of evaporated LiF films on silver or aluminum were determined by attenuated total reflection techniques as a function of time after deposition. With the LiF films maintained in vacuum, the refractive index increased from ~1.3 to ~1.4, or close to the crystalline value, in the course of a few days. This implies that the LiF, loosely packed when first deposited, anneals over a period of time to the more closely packed crystalline configuration. The LiF films were found to be optically isotropic in contrast to earlier reports of anisotropy.

41351 Luminescence of the F center in sapphire. Lee, K.H.; Crawford, J.H. Jr. (Department of Physics and Astronomy, University of North Carolina, Chapel Hill, North Carolina 27514). *Phys. Rev., Sect. B. Condens. Matter;* **19**: No. 6, 3217-3221(15 Mar 1979).

An F-center emission band (3 eV) has been observed in subtractively colored Al_2O_3 crystals upon exciting with F light (6.1 eV). The lifetime of the 3-eV luminescence is 36 +- 4 msec. We attribute this long lifetime to the forbidden triplet-to-singlet transition of the F center. The F bold-arrow-left-right F^+ conversion can be shown by studying the F and F^+ emission bands in these crystals.

41352 Electromodulation spectroscopy of excitons in simple cubic TlCl and TlBr. McClelland, J.F.; Lynch, D.W. (Ames Laboratory-USDOE and Department of Physics, Iowa State University, Ames, Iowa 50011). *Phys. Rev., Sect. B. Condens. Matter;* **19**: No. 6, 3244-3251(15 Mar 1979).

Transmission and electromodulated transmission spectra have been measured in the direct Wannier exciton region for TlCl and TlBr. The spectra were obtained at a sample temperature between 5 and 6 K for a range of applied electric fields. The data have been reduced to obtain the electric-field-induced changes in the dielectric function and compared in detail to the calculations of Blossey. The experimental results support the trends predicted by the calculations.

41353 Energy-level diagram and magnetic properties of the Pr^{3+} ion in the double molybdate $CsPr(MoO_4)_2$. Skorobogatova, I.V.; Khats'ko, E.N.; Gladchenko, S.N. (Physicotechnical Institute of Low Temperatures, Academy of Sciences of the Ukrainian SSR). *Sov. J. Low Temp. Phys. (Engl. Transl.);* **4**: No. 8, 505-507(Aug 1978).

In order to reconstruct the energy-level diagram of the principal term $^3H_4$ of the Pr^{3+} ion in the crystal field of the single crystal of the orthorhombic molybdate $CsPr(MoO_4)_2$, we study the optical absorption spectra in the range 1—2.5 μ over temperatures ranging from 4.2 to 300°K as well as the temperature dependence of the magnetic susceptibility along the principal magnetic axes over the same temperature range. Within the framework of crystal-field theory, as expressed by van Vleck's formula, we calculate the temperature dependence of the magnetic susceptibility.

41354 Experiments on the coexistence of superconductivity and long-range magnetic order in ternary rare earth compounds. Maple, M.B. (Univ. of California, San Diego, La Jolla). pp 381-394 of Rare earths in modern science and technology. McCarthy, G.J.; Rhyne, J.J. (eds.). New York, NY; Plenum Press (1978).

From 13. rare earth research conference; Olgebay Park, WV, USA (16 Oct 1977).

Superconducting ternary rare earth (RE) compounds provide a unique opportunity to study the coexistence of superconductivity and long-range ordering of RE magnetic moments. Recent investigations of the interaction between superconductivity and long-range magnetic order in the RE molybdenum selenides RE/sub x/Mo_6Se_8 and RE rhodium borides $RERh_4B_4$ are reviewed.

CORROSION, EROSION, AND DEGRADATION

41355 (CONF-780819—P1, pp 379-393) **Determination of the attrition resistance of granular charcoals.** Dietz, V.R. (Naval Research Lab., Washington, DC). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

A laboratory procedure has been developed to evaluate the attrition of granular adsorbent charcoals on passing an air flow through the bed. Two factors observed in plant operations were selected as relevant: (1) the characteristic structural vibrations in plant scale equipment (motors, fans, etc.) that are transmitted to charcoal particles and cause the particles to move and rub each other, and (2) the rapid air flow that results in the movement of the attrited dust. In the test a container for charcoal [50 mm diameter and 50 mm high] was vibrated at a frequency of 60 Hz and at a constant energy input manually controlled using a vibration meter in the acceleration mode. Simultaneously, air was applied and exited through glass fiber filter paper. The quantity of dust trapped on the exit filter was then determined, either optically or gravimetrically. The dust formed per minute (attrition coefficient) was found to approach a constant value. The plateau-values from sequential determinations varied with the source of the charcoal; a 5-fold difference was found among a large variety of commercial products. The first testing of a sample released the excess dust accumulated in previous handling of the charcoal. The plateau values were then attained in the succeeding tests and these were characteristic of the material. The results were compared with those obtained for the same charcoals using older test methods such as the Ball and Pan Hardness Test described in RDTM16-1T (October 1973).

41356 Fluctuations near the percolation threshold in two and three dimensions. Birgeneau, R.J.; Cowley, R.A.; Shirane, G. (Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *J. Appl. Phys.;* **50**: No. B3, 1788-1789(1 Mar 1979).

A series of quasielastic and inelastic neutron scattering experiments have been performed in the diluted insulating antiferromagnets, Rb_2Mn/sub c/Mg/sub 1-c/F_4, Rb_2Co/sub c/Mg/sub 1-c/F_4, Mn/sub c/Zn/sub 1-c/F_2 and KMn/sub c/Zn/sub 1-c/F_4. The concentrations c were chosen so as to span the percolation threshold value c=c/sub p/; for c<c/sub p/ no long range order is observed. We describe briefly the results of these experiments with special emphasis on the development of the magnetic correlations at low temperatures for samples with c≃c/sub p/.

RADIATION EFFECTS

41357 Defects, diffusion and radiation effects. Young, F.W. Jr.; Stiegler, J.O. (Oak Ridge National Lab., TN (USA)); Cost, J.R. (Energy Research and Development Administration, Washington, DC (USA). Div. of Physical Research); Nowick, A.S. (Columbia Univ., New York (USA)). *Mater. Sci. Eng.;* **35**: No. 1, 91-117(Sep 1978).

Defects, diffusion and radiation effects were considered for all types of materials. This subject area overlaps that of many of the other workshops and therefore the scope was limited as follows. Dislocations and grain boundaries were considered only as they related to other defects; consideration was given to radiation effects in semiconductors, but not to semiconductor physics; radiation effects in superconductors were considered only peripherally, as were radiation effects on surface; impurities were considered to be defects; solid state chemical reactions which involve defects and diffusion were not considered in detail.

41358 Raman scattering from boron-implanted laser-annealed silicon. Engstrom, H.; Bates, J.B. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Appl. Phys.;* **50**: No. 4, 2921-2925(Apr 1979).

Measurements of the line shape of the silicon optic mode in boron-implanted ruby-laser-annealed silicon were analyzed assuming a Fano-type interaction between the discrete optic mode and the continuous valence band states. The results yielded a utilization coefficient of 0.89 +- 0.09 for the boron impurities. Measurements of the ratio of the intensity of the boron local mode to that of the silicon optic mode as a function of excitation wavelength are consist-

ent with the conclusion of other workers that laser annealing is more effective than thermal annealing in reducing lattice damage.

41359 Impurity segregation by pulsed laser irradiation. White, C.W.; Narayan, J.; Appleton, B.R.; Wilson, S.R. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Appl. Phys.;* 50: No. 4, 2967-2969(Apr 1979).

Changes in profiles of implanted impurities in silicon and associated microstructural changes as a result of high-power laser pulses have been studied using ion- scattering channeling and transmission electron microscopy. The results show a significant segregation in the form of precipitates at and away from the dislocations in the near-surface regions for impurities such as copper and iron in silicon which have very low equilibrium solubilities and equilibrium distribution coefficients.

41360 Effect that the coagulation of radiation defects have on the durability properties of construction materials. Novikov, V.S. pp 85-95 of Radiatsionnye effekty izmeneniya mekhanicheskikh svoisty konstruktsionnykh materialov i metody ikh issledovaniya. Pisarenko, G.S. (ed.). Kiev, USSR; Izdatel'stvo Naukova Dumka (1977). (In Russian)

From 2. All-Union conference on the radiation effects of the change in the mechanical properties of construction materials and methods of investigating them; Kiev, USSR (Apr 1976).

An examination is made of a mathematical model that analyzes the effect of the coagulation of radiative pores have on the swelling of construction materials under conditions of large temperature gradients. 9 references.

CHEMISTRY

ANALYTICAL AND SEPARATIONS CHEMISTRY

REFER ALSO TO CITATION(S) 40062, 40118, 40119, 42141

41361 (LA—7698) **Determination of total gas in lithium tritide-deuteride compounds.** Smith, M.E.; Koski, N.L.; Waterbury, G.R. (Los Alamos Scientific Lab., NM (USA)). Apr 1979. Contract W-7405-ENG-36. 8p. Dep. NTIS, PC A02/MF A01.

Lithium tritide—deuteride samples are enclosed in a copper foil and decomposed by heating to 850°C in a copper reaction tube in vacuum. The temperature and pressure of the evolved gas, collected in a measured volume using a Toepler pump, are measured to determine the total moles of gas released from the sample. The gas is transferred to a removable sample bulb and, if required, analyzed for gaseous constituents by mass spectrometry. Based on 14 total gas determinations for a lithium deuteride sample, the calculated relative standard deviation was 1.0% and the estimated bias was <2.5%.

41362 (MLM—2615) **Refractive index method for at line determinations of hydrogen peroxide in cleaning baths.** Kapsch, D.M.; Woltermann, H.A. (Mound Facility, Miamisburg, OH (USA)). 11 May 1979. Contract AC04-76DP00053. 10p. Dep. NTIS, PC A02/MF A01.

Density and refractive index methods for determining hydrogen peroxide in cleaning baths were compared to the potassium permanganate titration method. The refractive index method was shown to be rapid and simple and required only a few drops of sample. This method exhibited a +- 0.14% H_2O_2 standard deviation for a single measurement and an average bias of - 0.002% H_2O_2 compared to the titration method. The refractive index method has been implemented and is being used at line for fast process results at a substantial cost savings.

41363 (N—79-10166) **Chemical properties and methods of analysis of refractory compounds.** Samsonov, G.V.; Frantsevich, I.N.; Yeremenko, V.N.; Nazarchuk, T.N.; Popova, O.I. (National Aeronautics and Space Administration, Washington, DC (USA)). Oct 1978. Translated from Khimicheskiye Svoystua I Metody Analiza Tuqoplavkikh Soyedineniy, 1969, p. 1-164. 201p. NTIS PC A10/MF A01.

Reactions involving refractory metals and the alloys based on them are discussed. Chemical, electrochemical, photometric, spectrophotometric, and X-ray analysis are among the methods described for analyzing the results of the reactions and for determining the chemical properties of these materials.

ACTIVATION AND NUCLEAR REACTION PROCEDURES

REFER ALSO TO CITATION(S) 40077, 40117, 41765

41364 Determination of nitrogen in atmospheric aerosols by proton activation analysis. Clemenson, M.; Novakov, T.; Markowitz, S.S. (Univ. of California, Berkeley). *Anal. Chem.;* 51: No. 4, 572-575(Apr 1979).

Nuclear reactions induced by low-energy protons are used to determine total nitrogen in atmospheric aerosols. Radioactive ^{11}C, a 20.4-min positron emitter, is detected unambiguously via its 0.511-MeV annihilation radiation following the $^{14}N(p,\alpha)^{11}C$ reaction. The detection system consists of a Ge(Li) γ-ray spectrometer that is calibrated for its absolute detection efficiency with ^{22}Na standards. The method is nondestructive of the sample, permitting the same sample to be studied by other experiments such as electron spectroscopy for chemical analysis. A comparison of nitrogen found by our proton activation method with that found by an independent but destructive combustion method gave an average percent difference of 14% for 17 samples analyzed over a concentration range that spans two orders of magnitude. Using realistic proton intensities and γ-ray detection coefficients, we estimate a nitrogen detection limit of approximately 0.1 $\mu g/cm^2$, corresponding to 200 ppM in an aerosol sample of thickness 500 $\mu g/cm^2$. 4 figures, 2 tables.

CHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 40106

41365 (ORNL/TM—6753) **Reverse-phase HPLC studies of mono- and dialkylphosphoric acids as phenacyl and naphthacyl derivatives to enhance ultraviolet detection.** Manning, D.L. (Oak Ridge National Lab., TN (USA)). May 1979. Contract W-7405-ENG-26. 16p. AT.

Liquid chromatographic studies were carried out on several selected mono- and dialkylphosphoric acids which act as extractants in nuclear fuel technology. For these high-performance liquid chromatography (HPLC) studies, we used a 25-cm Partisil-10 ODS-2 reverse-phase column and methanol-water as the mobile phase. These organophosphoric acids exhibit weak ultraviolet (uv) absorbance; however, we were able to greatly enhance uv detectability by preparing phenacyl and naphthacyl derivatives prior to injection onto the column. The formation of chemical derivatives is common in gas chromatography, but is comparatively rare in liquid chromatography. By tagging a molecule of interest with a strong uv chromophore, it is possible to place liquid chromatography detection limits on par with gas chromatography. The elution parameters for several mono- and dialkylphosphoric acids were evaluated.

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 40116, 40361

41366 Determination of trace elements in light element matrices by x-ray fluorescence spectrometry with incoherent scattered radiation as an internal standard. Giauque, R.D.; Garrett, R.B.; Goda, L.Y. (Univ. of California, Berkeley). *Anal. Chem.;* 51: No. 4, 511-516(Apr 1979).

A method for the direct determination of trace elements in light element matrices is described. It takes advantage of the fact that the incoherent mass scattering coefficient for 17.4 keV Mo Kα radiation is relatively constant for the elements Li(Z = 3) → Ca (Z = 20). Consequently, incoherent scattered Mo Kα excitation radiation, corrected for matrix absorption, can serve as an internal standard which compensates for variations in sample mass, x-ray tube output, and sample geometry. Samples of ~ 0.5 g are prepared in the form of thin specimens (~ 0.08-cm thick) in a cell between two 0.0006-cm thick polypropylene windows. Standardization for most elements is achieved using standard aqueous solutions diluted to ~ 100 ppM. Data obtained from simultaneous transmission measurements for several x-ray energies are used to calculate matrix absorption corrections. For 15-min analysis periods, results are typically accurate to within +-10% when x-ray counting statistics are not the limiting factor. Sensitivities of 2 ppM or better are realized for 16 of the 22 elements determined (Ti → Zr, Hg, Pb, Th, and U). 7 figures, 7 tables.

41367 (PB—286967) **Investigation of the chemical identity of soluble organophosphorus compounds found in natural waters. Research report.** Minear, R.A. (Tennessee Univ., Knoxville (USA). Water Resources Research Center). Apr 1978. 148p. NTIS PC A07/MF A01.

Four algal species (Chlamydomonas reinhardtii, Chlorella pyrenoidosa, Anacystis nidulans, and Anabaena flos-aquae) were grown in batch culture on ^{32}P labelled media to yield dissolved organic phosphorus (DOP) compounds containing a radioactive tag. The DOP compounds of filtered culture solutions were characterized by Sephadex gel filtration and thin layer chromatography (TLC) as a function of culture age. Additional TLC of individual Sephadex fractions was conducted. Time, culture and known com-

pounds (inositol mono- and hexaphosphate) comparisons were made. High performance liquid chromatography was used to separate inositol mono- and hexaphosphates and to compare the DOP components of one algal species (C. reinhardtii) with inositol phosphates. Combinations of alkaline bromination and Sephadex pretreatment were examined.

SPECTRAL PROCEDURES

REFER ALSO TO CITATION(S) 40078, 40079, 41377

41368 (PB—284859) **Investigation of matrix interferences for AAS trace metal analyses of sediments.** McKown, M.M.; Tschrin, C.R.; Lee, P.P.F. (Gulf South Research Inst., New Orleans, LA (USA)). May 1978. 140p. NTIS PC A07/MF A01.

The research was initiated with the overall objective of developing reliable, cost-effective methods utilizing flame atomic absorption spectrophotometry for the trace elemental analysis of soil and sediment samples containing complex matrices. The soil sample matrix studied consisted of more than 0.1 percent aluminum and iron; the sediment sample matrix contained more than 0.1 percent aluminum and iron plus lesser quantities of calcium, magnesium, manganese, phosphate and potassium. Conventional flame AAS methods were found to produce accurate results for the analyses of cobalt, copper, lead, manganese, nickel and zinc in these matrices. The barium, calcium, strontium and vanadium content of these samples could not be accurately determined by conventional flame AAS techniques. However, reliable results were obtained using appropriate flame types with the addition of lanthanum and/or an easily ionizable alkali salt to all samples and standards.

41369 **Polarization-sensitive coherent anti-Stokes Raman spectroscopy.** Oudar, J.; Smith, R.W.; Shen, Y.R. (Department of Physics, University of California, Berkeley, California 94720). *Appl. Phys. Lett.;* **34**: No. 11, 758-760(1 Jun 1979).

We show that by using polarization coherent anti-Stokes Raman spectroscopy, the detection sensitivity of weak Raman modes is greatly enhanced. The spectra of the real part, the imaginary part, and the absolute magnitude of the resonant nonlinear susceptibility can be separately measured. Raman modes with cross sections as low as 2×10^{-4} times that of the 992-cm^{-1} mode of benzene are detectable with less than 10-kW-peak-power lasers.

41370 **Laser-collision induced chemical reactions: Collinear exchange reaction model on two electronic surfaces.** Light, J.C.; Altenberger-Siczek, A. (The James Franck Institute and The Department of Chemistry, The University of Chicago, Illinois 60637). *J. Chem. Phys.;* **70**: No. 9, 4108-4116(1 May 1979).

A collinear model of bimolecular exchange reactions in the presence of an intense laser field coupling two electronic potential energy surfaces is developed. Close coupling calculations for two model systems were carried out as a function of the initial energy, E, the laser coupling, μE_0, and the laser frequency, $\hbar\omega$. It is shown that the reaction probability can be greatly altered for some systems by intense off-resonant laser radiation. A suggestion is made for laser frequency up-conversion using exothermic chemical reactions.

SEPARATION PROCEDURES

REFER ALSO TO CITATION(S) 40371, 40374, 40931

41371 (DP—1489, pp 29-30) **Construction status of the three-stage mass spectrometer for plutonium isotope measurements.** Halverson, J.E. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The purpose of the three-stage high sensitivity mass spectrometer currently being assembled at the Savannah River Laboratory (SRL) is to provide ultra low-level isotope analyses to support current research programs. Initially, the instrument will measure isotope ratios required for research on plutonium transport in the environment and for determining the characteristics of plutonium-bearing particles. Also, the spectrometer will be expected to support other environmental research, in particular, research programs concerning long-lived fission products in the environment.

41372 (ORNL/TM—6776) **Method of estimating distribution coefficients of degradation products from organophosphorus extractants.** Katz, S.; Bond, W.D. (Oak Ridge National Lab., TN (USA)). May 1979. Contract W-7405-ENG-26. 26p. Dep. NTIS, PC A03/MF A01.

The total phosphorus content of stripping solutions after their equilibration with organophosphorus extractants in successive contacts with fresh strip solution was employed to estimate the concentrations of phosphorus-containing hydrolysis (or degradation) products in the extractant phase and their distribution coefficients. Aqueous solutions and ethylene glycol were used as stripping agents. The procedure is especially useful for estimates of the concentrations of phosphorus-containing impurities that are originally present in the extractant or that are generated in separations processes. The utility of the method was demonstrated for spearations processes that employ the following extractants: di-(2-ethylhexyl)-phosphoric acid, tributyl phosphate, and dihexyl-N,N-diethylcarbamylmethylene phosphonate.

41373 **Statistical designs for the optimization of the nitrogen—phosphorus gas chromatographic detector response.** Rubin, I.B.; Bayne, C.K. (Oak Ridge National Lab., TN). *Anal. Chem.;* **51**: No. 4, 541-546(Apr 1979).

Statistically designed and evaluated factorial experiments were used to approach optimum operating conditions for the rubidium bead type of nitrogen—phosphorus gas chromatographic detector to detect small quantities of nitrogen compounds in a hydrocarbon matrix, and to study the effects of the operating variables. Simplex designs were used to define the optimum set of conditions. The test variables were hydrogen pressure, air pressure, and bead heating current. Only two 2^3 factorial designs and ten simplex vertices were needed to accomplish these purposes. Detector responses for 12 nitrogen and 12 hydrocarbon compounds were compared with both the nitrogen—phosphorus and flame ionization detectors. The average value of the ratio of nitrogen to hydrocarbon response with the nitrogen-sensitive detector was about 1000:1. Chromatography of several fractions from a chemical extractive fractionation of a coal liquefaction product oil demonstrated the discrimination capability of the nitrogen—phosphorus detector at optimum conditions. 4 figures, 4 tables.

INORGANIC AND PHYSICAL CHEMISTRY

REFER ALSO TO CITATION(S) 40147, 40162

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 40090, 40164, 40284, 40301, 40402, 40489, 40494

41374 (BNL—26072) **Dependence of conduction band energy and electron mobility on fluid density.** Holroyd, R.A.; Cipollini, N.E. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 8p. (CONF-790524—2). Dep. NTIS, PC A02/MF A01.

From 6. international congress symposium on radiation research and stem cells; Tokyo, Japan (13 May 1979).

Measurements of electron mobility and conduction band energy are reported as a function of density for neopentane and tetramethylsilane. Electron mobilities are for the gas phase at a temperature just above the critical temperature and for densities between 0.1 and 3.0×10^{21} molecules/cc. The band energies (V_0) are for the gas phase over the same density range and temperature as well as for the liquid from 25° to the critical temperature. These data permit a comparison between V_0 and electron mobility over the entire density range. At low densities V_0 from work function shifts is given by $(h^2/2\pi m)N\alpha$, where the parameter α can be evaluated from mobility data. At an intermediate density there is a transition and V_0 changes abruptly to more negative values; in this transition region the mobility is minimum. Throughout the intermediate and high density range V_0 remains negative and changes only very slowly. The electron mobility is a maximum at a density of 3.5×10^{21} molecules/cc where V_0 is a minimum. In this density range the electron is scattered by density fluctuations which perturb the potential.

41375 (EPA—600/7-78-058b, pp 884-901) **Reduction of magnesium and sodium sulfites and sulfates.** Lowell, P.S. (P.S. Lowell and Co., Inc., Austin, TX). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

The reduction of the sulfites and sulfates of magnesium and sodium to elemental sulfur is a consideration in air pollution control processes both as a process option and a means of regenerating magnesium and sodium compounds for recycle. The chemical basis for sulfate and sulfite reduction is considered in this paper. Both the thermodynamic and kinetic limitations are explored. A calculated process design for the production of elemental sulfur from magnesium sulfite/sulfate is given and discussed. The sodium system is more complex than the magnesium system. It was concluded that both thermodynamic and kinetic considerations are important in either process. The magnesium salts require less reducing gas than the sodium system because the oxide rather than the sulfide is produced in the reduction step. The process temperature has a lower limit imposed by gas phase kinetics. Sodium sulfite/sulfate reduction

is more complex because of the extreme chemical stability of the sodium compounds. Sulfide formation occurs so that excess reductant is required. High temperatures are necessary because of solid and gas phase kinetics. The endothermic nature of the reaction requires that heat be added.

41376 Solution of the Debye—Smoluchowski equation for the rate of reaction of ions in dilute solution. Rice, S.A.; Butler, P.R.; Pilling, M.J.; Baird, J.K. (Radiative and Surface Chemistry Group, Building 540 Chemistry Division, AERE Harwell, OX11 ORA, United Kingdom). *J. Chem. Phys.;* 70: No. 9, 4001-4007(1 May 1979).

Reactions of isolated ion pairs in solution have been modelled using the Debye—Smoluchowski equation for diffusion and conduction. An activation step was incorporated using a partially reflecting boundary condition. The method of matched expansions and the Abelian theorem of Laplace transforms was used to give an approximate solution of the Debye—Smoluchowski equation. Numerical integrations based on the finite-difference method confirmed these approximate analytic formulas.

41377 Characterization of coprecipitated nickel on silica methanation catalysts by x-ray photoelectron spectroscopy. Shalvoy, R.B.; Reucroft, P.J.; Davis, B.H. (Univ. of Kentucky, Lexington). *J. Catal.;* 56: No. 3, 336-348(15 Mar 1979).

An x-ray photoemission spectroscopy study of a series of standard nickel compounds (Ni, NiO, $Ni(OH)_2$, $NiSiO_3$) and silica-supported nickel methanation catalysts has been conducted. The binding energies and spectral shapes of the standard samples provide a data base which has been used to understand the catalyst spectra. The activity and thermal stability of coprecipitated nickel catalysts has been attributed to the metal-support interaction. This interaction has been observed in two coprecipitated nickel-on-silica catalysts. The nickel spectra closely resemble those of amorphous $NiSiO_3$. The interaction varies somewhat between the two catalysts studied as evidenced by differences in their reducibility. 6 figures, 4 tables.

ISOTOPE EFFECTS

41378 Oxygen-18 isotope effects in the electronic spectrum of UO_2F_2. Temperature effects. DePoorter, G.L.; Rofer-DePoorter, C.K. (Los Alamos Scientific Lab., NM (USA)). *Inorg. Nucl. Chem. Lett.;* 14: No. 10, 333-335(1978).

The substitution of ^{18}O for ^{16}O in UO_2F_2 produces changes in the electronic spectrum. Both positions and intensities of peaks change. To clarify these changes, the well-known narrowing effect of lowered temperature on the uranyl spectrum was used. The spectrum of UO_2F_2 in methanol at 203 K supports the conclusions based on the room-temperature spectrum. Experimental details are presented, and results are discussed.

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 41371

ORGANIC CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 40489

41379 (COO—3435-30) **Microwave-optical double resonance spectroscopy. Progress report, February 1, 1978—January 31, 1979.** Pratt, D.W. (Pittsburgh Univ., PA (USA). Dept. of Chemistry). 1 Nov 1978. Contract EY-76-S-02-3435. 30p. Dep. NTIS, PC A03/MF A01.

Optical, zero-field and high-field optical detection of magnetic resonance, electron-nuclear double resonance, level anticrossing and cross relaxation, and electron paramagnetic resonance experiments have been performed on a variety of chemical systems in order to further basic knowledge of the structure, reactivity, and response to radiation of molecules in their ground and/or excited electronic states. Systems investigated include organic molecules oriented in low temperature crystals, simple free radicals, transition metal complexes, rare earth hydrides, and hemeproteins in biological enzymes. Aside from their intrinsic interest, many of these systems are of potential importance in a number of applied areas including hydrocarbon-based fuel systems, solar energy devices, laser-initiated photochemical reactions, and free radical mechanisms in chemical carcinogenesis.

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

41380 Selective isotope dissociation of high-pressure CF_3I with a pulsed CO_2 laser. Bagratashvili, V.N.; Dolzhikov, V.S.; Letokhov, V.S.; Ryabov, E.A. (Institute of Spectroscopy, Academy of Sciences of the USSR, Troitsk). *Sov. Tech. Phys. Lett. (Engl. Transl.);* 4: No. 10, 475-477(Oct 1978).

A study of selective isotope dissociation of CF_3I molecules is described. The results show that the requirements of high dissociation yield, high quantum yield, high selectivity and capability of working at high concentrations of the initial material are met, insuring maximum efficiency of the method.

ELECTROCHEMISTRY

41381 Electrochemical and surface analytical characterization of titanium and titanium hydride thin film electrode oxidation. Quinn, R.K.; Armstrong, N.R. (Sandia Lab, Albuquerque, NM). *J. Electrochem. Soc.;* 125: No. 11, 1790-1796(Nov 1978).

The oxidation of the active, high energy density materials, titanium and titanium hydride, has been studied by electrochemical and electron spectroscopic techniques. The apparent thickness of the oxide was controlled by the magnitude of the applied potential across thin (200-6000 A) films of these materials. Our electrochemical measurements indicated that after irreversible oxide formation, the thin films behaved as typical semiconducting oxide electrodes. A technique of electrochemical aging is described which permits comparison with oxide thicknesses produced by thermal aging. Post mortem analysis by XPS and AES was used to characterize the extent of oxidation of the film surface. The results of the experiments are compared for titanium and titanium hydride and are examined with respect to a model for oxide formation and growth.

PHOTOCHEMISTRY

REFER ALSO TO CITATION(S) 40544

41382 Zero pressure lifetimes and fluorescence quenching of ICl($A\ ^3\Pi_1$). Harris, S.J.; Natzle, W.C.; Moore, C.B. (Department of Chemistry, University of California, and Materials and Molecular Research Division of the Lawrence Berkeley Laboratory, Berkeley California 94720). *J. Chem. Phys.;* 70: No. 9, 4215-4219(1 May 1979).

Lifetimes of ICl($A\ ^3\Pi_1$) are measured by laser-induced fluorescence. Zero pressure lifetimes for excitation between 589 and 669 nm range from 405 +- 40 to 460 +- 40 μsec. Quenching cross sections measured at 293°K near 603 nm vary between 110 A^2 for ICl itself and 0.7 A^2 for Ne. A radiative lifetime of about 650 μsec was estimated from the integrated absorption spectrum.

41383 Infrared laser enhancement of chemical reactions via collision induced absorption. Orel, A.E.; Miller, W.H. (Department of Chemistry, and Materials and Molecular Research Division of the Lawrence Berkeley Laboratory, University of California Berkeley, California 94720). *J. Chem. Phys.;* 70: No. 9, 4393-4399(1 May 1979).

We have pointed out previously that an infrared laser will in general enhance the rate of a chemical reaction via a collision induced absorption, even if the reactants themselves are infrared inactive. This paper examines this phenomenon more fully by presenting a simple analytically solvable model which illustrates it and also by presenting the results of classical trajectory calculations we have carried out for the reactions $X+H_2$arrow-right-left$HX+H$, for X=H, F, Cl. One new feature which is revealed by these calculations is that the polarization of the laser is an important parameter, i.e., certain polarizations are much more effective in enhancing the rate of the reaction than others.

RADIATION CHEMISTRY

REFER ALSO TO CITATION(S) 40485, 40486

41384 (NDRL—1941) **Radiation Laboratory, Univ. of Notre Dame, quarterly report, July 1, 1978—September 30, 1978.** (Notre Dame Univ., IN (USA). Radiation Lab.). 13 Oct 1978. Contract EY-76-C-02-0038. 60p. Dep. NTIS, PC A04/MF A01.

Progress is reported briefly in several areas of research, including photochemistry, radiolysis, radioinduced polarization, etc. Abstracts for articles submitted for publication during the quarter are included. (JGB)

41385 Radiation curable compositions. Batt, C.B.; Kucharska, H.Z.; Jansen, A. (to Reichhold Chemicals Ltd.). US Patent 4,137,138. 30 Jan 1979. Priority date 7 Nov 1974, Canada, 8p.

A radiation curable composition suitable for use in coating or printing ink applications is described. The composition consists of a mixture of an unsaturated polyester prepared from polyhydric alcohol, unsaturated dicarboxylic acid, or unsaturated ether type polyester prepared from polyglycidyl ether and unsaturated monocarboxy-

lic acid with a saturated monomer of lactone or lactam. The composition can be cured either with or without the addition of a photoinitiates.

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

PROPERTIES OF RADIOACTIVE MATERIALS

REFER ALSO TO CITATION(S) 40378, 41378

RADIOISOTOPE PRODUCTION

41386 (BNL—25802) **BLIP production of Fe-52 and the Mn-52m generator.** Ku, T.H.; Richards, P.; Stang, L.G.; Prach, T. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 9p. (CONF-790321—5). Dep. NTIS, PC A02/MF A01.

From 2. international symposium on radiopharmaceuticals; Seattle, WA, USA (18 Mar 1979).

Fe-52 (t 1/2 = 8.275 h) is the only radioisotope of iron with decay properties suitable for imaging applications (100% 169-keV and 112% annihilation gammas). It can also be used in a Fe-52/Mn-52m generator system as a source of Mn-52m (t 1/2 = 21.1m) which is a short-lived positron emitter (192.54% annihilation gammas). Clinically useful quantities of Fe-52 have been prepared at the Brookhaven Linac Isotope Producer (BLIP) by bombarding manganese or nickel targets with medium-energy protons. After chemical separation, Fe-52 is loaded onto a generator column from which carrier-free Mn-52m is eluted. The Mn-52m generator is potentially useful in positron emission computed tomography.

COMBUSTION, PYROLYSIS, AND HIGH-TEMPERATURE CHEMISTRY

41387 (SAND—78-8686) **Numerical study of the interaction of fast chemistry and diffusion.** Otey, G.R.; Dwyer, H.A. (Sandia Labs., Livermore, CA (USA); California Univ., Davis (USA)). Apr 1979. Contract EY-76-C-04-0789. 14p. (CONF-780790—1). Dep. NTIS, PC A02/MF A01.

From 14. AIAA/SAE joint propulsion conference; Las Vegas, NV, USA (25 Jul 1978).

A model problem which contains the essential features of most combustion processes has been formulated and is used to characterize the efficiency of five numerical solution procedures. Chemistry is modeled by both one and two-step Arrhenius-type reactions which allow the effect of stiffness on the efficiency of the methods to be parametrically assessed. The numerical schemes evaluated include two method of lines techniques, two methods that integrate reaction terms point-by-point, and a linearized block tridiagonal, implicit procedure. The latter technique with fourth order Pade' spatial differences has been found to be most efficient over a wide range of reaction rates including cases with considerable stiffness. Combination of this method with adaptive gridding schemes and extension of the method to two-dimensional problems of combustion in a gaseous medium are discussed qualitatively.

ENGINEERING

41388 (NP—23713) **Research and development work in the division of mechanical engineering.** (National Research Council of Canada, Ottawa, Ontario). 1978. 100p. Dep. NTIS, PC A05/MF A01.

Mechanical engineering research activities during 1978 that are for the purpose of aiding Canadian industries are reviewed. Research studies in transportation technology, including railroad, roadway, marine, air, and pipeline transport, in industrial and manufacturing technology in energy-related research, in medical and human engineering studies, and in the development of standards for industrial products and equipment are described. (LCL)

GENERAL ENGINEERING

REFER ALSO TO CITATION(S) 40799

FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 40076, 40794, 41062, 41454

41389 **Floor crane safety.** Boster, T.A. (Univ. of California, Livermore). *Prof. Saf.;* 18-24(Jul 1978).

There are a wide variety of small hand operated movable hydraulic floor cranes. These floor cranes are designed to transport loads in the 100 to 6000 lb. range on smooth level surfaces. Although these floor cranes are fabricated from a wide variety of structural steel shapes and an even wider variety of wheels, casters, pumps, and other components they all have certain basic features that can be compared. The safety aspects that one should consider in using small floor cranes are discussed. In addition, the safe operation and specific safety procedures and crane features that are desirable are pointed out. The use of a simple tether rope to prevent crane tip over is presented in detail.

41390 (LA-UR—78-3169) **Heat pipe thermal control of slender optics probes.** Prenger, F.C. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 20p. (CONF-790611—1). Dep. NTIS, PC A02/MF A01.

From AIAA terrestrial energy systems conference; Orlando, FL, USA (4 Jun 1979).

The thermal design for a stereographic viewing system is presented. The design incorporates an annular heat pipe and thermal isolation techniques. Test results are compared with design predictions for a prototype configuration. Test data obtained during heat pipe startup showing temperature gradients along the evaporator wall are presented. Correlations relating maximum wall temperature differences to a liquid Reynolds number were obtained at low power levels. These results are compared with Nusselt's Falling Film theory.

41391 (SAND—78-2336C) **Transient elastodynamic response of a circular crack in a thick plate under torsion.** Chen, E.P. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 14p. (CONF-790615—1). Dep. NTIS, PC A02/MF A01.

From 3. US national congress on pressure vessels and piping; San Francisco, CA, USA (25 Jun 1979).

The elastodynamic response of a thick plate under torsion is considered. A penny-shaped crack is assumed to exist in the center of the plate such that the problem is axisymmetric in nature. The crack is pressurized suddenly along its surfaces resulting in transient conditions. This problem is also equivalent to that of sudden appearance of a crack in the loaded plate. Hankel and Laplace transforms are used to reduce the problem to the solution of a pair of dual integral equations. A numerical Laplace inversion routine is used to recover the time-dependence of the solution. The dynamic stress intensity factor is determined and its dependence on time and geometry is discussed.

41392 (SAND—78-2350C) **Expanding the region of convergence for SITAN through improved modelling of terrain nonlinearities.** Hostetler, L.D.; Beckmann, R.C. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 8p. (CONF-790525—2). Dep. NTIS, PC A02/MF A01.

From 8. IMEKO congress; Moscow, USSR (21 May 1979).

The SITAN (Sandia Inertial Terrain-Aided Navigation) system was originally developed to provide continuous updating of an inertial navigation system by using radar altimeter measurements of the terrain in conjunction with prestored topographic data in an extended Kalman filter. The basic algorithm performs satisfactorily for limited initial position uncertainties, but can diverge when the position uncertainty is so great that terrain linearity assumptions are significantly violated. An improvement to the basic system is described which considerably increases the region of convergence. The improvement is accomplished by modelling the terrain nonlinearities as Gauss-Markov measurement noise whose statistics and frequency content are adaptively varied as the uncertainty region evolves with time. Theoretical development of this modification is given and results of flight test experiments are presented which verify the ability of this modification to significantly increase SITAN's region of convergence.

41393 (SAND—79-0479) **Failure analysis of type 416 stainless steel gate valve.** Douglass, D.L. (Sandia Labs., Albuquerque, NM (USA)). May 1979. Contract EY-76-C-04-0789. 21p. Dep. NTIS, PC A02/MF A01.

A gate, made of type 416 stainless steel, used as a blocking valve in a steam injection line from a central steam generator failed after several days in the temperature range of 600 to 700°F. An oxidizing gas, 65% steam, 22% nitrogen, and 13% carbon dioxide passed through the valve with a pressure differential of about 1000 psi. The failed surface exhibited regions which appeared to have been gouged out and were highly irregular. Most of the failed surface was free from corrosion products. Recessed areas out of the impingement of the gas stream contained oxides: a thick outer region of slightly porous iron oxides, and an inner, thin layer of chromium-rich oxide. This structure represents a steady-state one requiring tens of hours to form. Its presence suggests that rapid erosion occurred followed by oxidation in the protected recesses. Erosion was the

primary cause of failure with a minor assist by corrosion. Sulfidation did not play a role, although a small amount of sulfur was detected. Preventative measures will require a much more abrasion-resistant gate alloy or a suitable hard coating such as TiB_2.

41394 Heat exchanger matrix for recuperative heat exchange among three media and modular heat exchangers combining a plurality of such matrices. Foerster, S.; Kleemann, M. (to Kernforschungsanlage Julich Gesellschaft m. beschraenkter Haftung). US Patent 4,148,357. 10 Apr 1979. Priority date 3 Nov 1975, German, Federal Republic of (F.R. Germany), 6p.

Two identically folded strips enclose an intermediate space accessible at the edges of the strip, and the fold cavities opening to the outside of the strip structure are closed off at the strip edges and covered by outside cover plates over their central portions, so that one medium may be caused to flow through each of the sets of outside fold cavities and a third medium through the intermediate space. The third medium flows countercurrent to the direction of flow of the other two. Modules of four such matrices utilize inlet and outlet ducts so that the two or four matrices in a compact modular structure can be structurally repeated in accordance with the number of modules desired in the particular application. The inlet and outlet ducts have tapering flow cross-sections.

41395 Adaptive approaches and reliability estimations in finite element analysis. Babuska, I.; Rheinboldt, W.C. (Univ. of Maryland, College Park). E(401)3443. *Comput. Methods Appl. Mech. Eng.;* **17/18**: 519-540(Mar 1979).

An overview is presented of the authors' recent theoretical and experimental results on reliable and computationally efficient a posteriori error estimates for finite element solutions. Basically, error indicators are evaluated on the individual elements, and from these an estimate of the error in the energy norm is composed. Up to now this theory of a posteriori estimates has been developed only for linear problems. Here it is indicated how the results can be extended to the nonlinear case without losing their effectivity. The error indicators also allow for a very effective approach to an adaptive design of finite element meshes that are (nearly) optimal in a certain sense. Finally, we outline the design of an experimental finite element system now under development which incorporates many of these ideas and results. Its principal goal is to produce (near) optimal finite element solutions within a prescribed cost range.

41396 Application of the finite element method to metal forming processes. Part I. Key, S.W. (Sandia Labs., Albuquerque, NM); Krieg, R.D.; Bathe, K.J. *Comput. Methods Appl. Mech. Eng.;* **17/18**: 597-608(Mar 1979).

Metal forming processes are characterized by large amounts of plastic flow which come from taking blanks or billets of elementry shape and distorting them into more useful geometries, generally more complicated. In terms of manufacturing technology, the field is divided into bulk forming and sheet forming. Bulk forming covers extrustion and plate rolling while sheet forming includes sheet metal stamping and stretch forming. Possibilities for using modern finite element method computational tools for the detailed examination of these processes are discussed. The purpose is to explore what aspects of metal forming are readily studied by computational mechanics. For example, the role of friction between the tool and the metal being formed is available for study. From the calculations it will be evident how the effects of changes in tool and die shapes may be explored as well as how formablity is affected by changes in stress-strain behavior from alloying.

41397 Air-to-air heat recuperating unit. Culbertson, D.L. US Patent 4,141,412. 27 Feb 1979. Filed date 27 Jan 1977. 10p.

The invention discloses a heat exchanger comprising a plurality of spaced sheets and a plurality of adjacent channels between successive layers of the sheets for the passage of air or other gases. Spacers are installed between successive layers for rigidly maintaining said sheets and for defining said channels, and splitters are mounted between adjacent channels for guiding the air flow from one channel to the next adjacent channel. The heat exchanger sheets are impressed with a unique pattern designed to further improve the heat transfer efficiency of the heat exchanger and to impart structural integrity to the assembly.

41398 Recent finite element studies in plasticity and fracture mechanics. Rice, J.R. (Brown Univ., Providence, RI); McMeeking, R.M.; Parks, D.M.; Sorensen, E.P. *Comput. Methods Appl. Mech. Eng.;* **17/18**: 411-442(Feb 1979).

Recent work on fundamentals of elastic—plastic finite-element analysis and its applications to the mechanics of crack opening and growth in ductile solids are reviewed. The presentation begins with a precise formulation of incremental equilibrium equations and their finite-element forms in a manner valid for deformations of arbitrary magnitude. Special features of computational procedures are outlined for accuracy in view of the near-incompressibility of elastic—plastic response. Applications to crack mechanics include the analysis of large plastic deformations at a progressively opening crack tip, the determination of J integral values and of limitations to J characterizations of the intensity of the crack tip field, and the determination of crack tip fields in stable crack growth.

41399 Dynamic analysis of large structural systems with local nonlinearities. Clough, R.W.; Wilson, E.L. (Univ. of California, Berkeley). *Comput. Methods Appl. Mech. Eng.;* **17/18**: 107-129(Jan 1979).

In many types of structures that exhibit significant nonlinearity during dynamic response the nonlinear stiffness property is confined to a few predetermined localities. This physical characteristic may be exploited by making use of substructure concepts in the dynamic response analysis. The elastic components may be represented by a small matrix of stiffness coefficients coupling them to the nonlinear elements, and only the properties of the few nonlinear elements need be modified during the response analysis. Both direct and indirect techniques for taking advantage of localized nonlinearity are reviewed here. In the direct methods the equations of motion are integrated by step-by-step procedures. Various methods of reducing the effective number of degrees of freedom are discussed. In the indirect methods the response to simple loadings is determined, and the response to the prescribed loading is obtained by superposition. A technique for applying superposition to the linear portion of the structure while treating the nonlinear region by a step-by-step procedure is described.

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 40818, 41229, 41852, 41991, 42099, 42100

41400 (LA—7654-PR) Magnetic refrigerator development. Progress report, September 1—November 30, 1978. Barclay, J.A.; Steyert, W.A.; Zrudsky, D.R. (Los Alamos Scientific Lab., NM (USA)). Mar 1979. Contract W-7405-ENG-36. 13p. Dep. NTIS, PC A02/MF A01.

The objectives of this program are to develop new, low-cost, high-efficiency magnetic refrigeration methods for cooling large superconducting devices of interest to the electric power industry. During this quarter, all the components were built and tested for a 1-kW gadolinium-wheel refrigerator to span a 40 K temperature range near ambient temperature. The refrigerator is now ready for final assembly and testing.

41401 (NTIS/PS—78/1261) Cryogenic refrigeration. Volume 2. 1973—October, 1977 (a bibliography with abstracts). Report for 1973—October 1977. Reed, W.E. (National Technical Information Service, Springfield, VA (USA)). Dec 1978. 236p. NTIS PC N01/MF N01.

Topics in the cited reports include cryogenic cooling of electronic equipment, infrared equipment, cryogenic storage vessels, magnetohydrodynamic generators, and superconducting magnets, coils, rotating machinery, and transmission lines. Marine refrigeration of liquefied natural gas, cryogenic heat pipes, cryogenic heat transfer, and space applications are studied. Methods investigated include adiabatic demagnetization, electrocaloric effect, Joule-Thompson effect, thermoelectric cooling, and Crayton, Claude, Gifford-McMahon, Sterling, and Vuilleumier cycles. (This updated bibliography contains 229 abstracts, none of which are new entries to the previous edition.)

41402 (NTIS/PS—78/1262) Cryogenic refrigeration. Volume 3. November, 1977-November, 1978 (a bibliography with abstracts). Report for November 1977—November 1978. Reed, W.E. (National Technical Information Service, Springfield, VA (USA)). Nov 1978. 84p. NTIS PC N01/MF N01.

Topics in the cited reports include cryogenic cooling of electronic equipment, infrared equipment, cryogenic storage vessels, magnetohydrodynamic generators, and superconducting magnets, coils, rotating machinery, and transmission lines. Marine refrigeration of liquefied natural gas, cryogenic heat pipes, cryogenic heat transfer, and space applications are studied. Methods investigated include adiabatic demagnetization, electrocaloric effect, Joule-Thomson effect, thermoelectric cooling, and Crayton, Claude, Gifford-McMahon, Sterling, and Vuilleumier cycles. (This updated bibliography contains 77 abstracts, all of which are new entries to the previous edition.)

41403 High critical currents in cold-powder-metallurgy-processed superconducting Cu-Nb-Sn composites. Fluekiger, R.; Foner, S.; McNiff, E.J. Jr.; Schwartz, B.B. (Francis Bitter National Magnet Laboratory, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Appl. Phys. Lett.;* **34**: No. 11, 763-766(1 Jun 1979).

Cold-powder-metallurgy-processed superconducting Cu-Nb-Sn (discontinuous) multifilamentary composites have been fabricat-

ed. Overall critical current J/sub c/ comparable to the best in situ and commercial multifilamentary Nb_3Sn (scaled for the same Nb content) have been achieved. Values of J/sub c/ approximately 10^5 A/cm² at 12 T, 5×10^4 A/cm² at 14 T, and 2×10^3 A/cm² at 18 T are observed for a material with Cu—40 wt.% Nb—20 wt.% Sn with respect to Cu. The physical characteristics of the starting materials and some advantages of the cold-powder-metallurgy process are discussed.

41404 Model of real superconducting point contacts. Divin, Y.Y.; Nad', F.Y. (Institute of Radio Engineering and Electronics, Academy of Sciences of the USSR). *Sov. J. Low Temp. Phys. (Engl. Transl.);* 4: No. 9, 520-525(Sep 1978).

A model of real superconducting point contacts is proposed based on the experimental studies of superconducting point contact properties in the resistance range 10^5—10^{-1} Ω and on a comparison with the structural properties of the contacts. According to this model, the contact is a parallel connection of a tunnel junction whose conductivity is due to quasiparticles, and a microshort jumper with Josephson properties. Within the framework of the proposed model, good agreement is obtained between the experimental and theoretical temperature dependences of the contact's critical current, and the observed dependence of the contact characteristic voltage V/sub C/ on the contact resistance is explained.

41405 Paraconductivity in nonuniform josephson junctions. Walker, P.L. Riverside, CA; Univ. of California (1976). 101p. University Microfilms Order No. 77-11,784.

Thesis (Ph. D.).

The time dependent Ginzburg—Landau equation is believed to describe the dynamics of the fluctuating order parameter of superconductors operated above their superconducting transition temperature, T/sub c/. In this theory the relaxation rate of the fluctuating order parameter is a linear function of temperature T for $T \geqq$ T/sub c/. However, recent experiments utilizing pair tunneling in Al-Al_2O_3-Pb junctions to directly measure the order parameter relaxation rate have indicated suppression of the relaxation rate from linearity over a temperature region much larger than the Ginzburg critical region. In order to explain this behavior two possible mechanisms are presented, first, the effect of random variations of the junction barrier thickness was calculated assuming Gaussian statistics and a Gaussian correlation function for the spatial variation in barrier thickness. Variations in thickness of root mean square amplitude of 1 °A and wavelength of 18,000 °A are needed to explain the data. Second, the effect of static fluctuations of the local T/sub c/ of the aluminum film on the dynamic order parameter is calculated in the Gaussian approximation. Fluctuations of average size approximately equal to the correlation length (T=0) and mean square amplitude $\langle (T/\text{sub c})^2 \rangle \approx 0.058$ give good agreement with the experimental data.

PROTECTIVE STRUCTURES AND EQUIPMENT

41406 (CONF-780819—P2, pp 1176-1184) **Performance and environmental characteristics of a compact, high-capacity HEPA filter design.** Rose, C.E.; Rivers, R.D. (American Air Filter Co., Inc., Louisville, KY). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

An improved version of the HEPA filter has been developed and evaluated for conformity with MIL-51068. In this design, the filter paper (conforming to MIL-F-51079) is pleated to a depth of only 18 mm. Ribbons essentially the same material as the filter paper form inter-pleat spacers, providing a crest-to-crest spacing of 3 mm. The resultant filter has the same DOP penetration level as the standard MIL-F-51068 HEPA filter, but about half its pressure drop at the same airflow. Materials of construction, adhesives, gaskets and faceguards match MIL-f-51068. Both flat-panel and zig-zag configurations of the filter meet the rough handling test of MIL-F-51068. Preliminary indications are that both filters will meet the overpressure tests of MIL-F-51068D and the flammability requirements of UL 586; these tests are in progress. Filters can be supplied to interchange with existing HEPA filter sizes. The improved pressure drop characteristic of these filters can be used to provide longer intervals between filter changes, or equal life at greater capacity.

41407 (CONF-780819—P2, pp 1185-1190) **Performance of 1,000 and 1800 CFM HEPA filters on long exposure to low atmospheric dust loadings.** First, M.W.; Leith, D. (Harvard Air Cleaning Lab., Boston, MA). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Comparative tests are in progress to determine the performance characteristics of European-design HEPA filters compared to US-design units made with the same filter paper. European filters are being operated at their rated capacity of 1,800 cfm and at 1,000 cfm. The US-design unit is operated at 1,000 cfm. Filters, installed on the roof of a 15-story building, are continuously exposed to an atmospheric dust aerosol of low concentration and small particle size. Plans are to continue these tests over a period of two or more years. Early results confirm that 1,800 cfm rated filters will have a very slow rate of pressure increase when operated at 1,000 cfm and an extended service life.

41408 (LA—7726-MS) **Ventilation system pressure transients: small-scale shock tube results.** LaPlante, D.; Smith, P.R.; Gregory, W.S. (Los Alamos Scientific Lab., NM (USA)). Apr 1979. Contract W-7405-ENG-36. 20p. Dep. NTIS, PC A02/MF A01.

A shock tube is proposed as a means of generating pressure pulses that simulate explosion pressures across ventilation system components. Experimental results using a 76-mm-dia shock tube to evaluate a proposed conceptual design for a 914-mm-dia shock tube are described. Shock tube driver length variation was shown to be an effective method for controlling pressure pulse duration. A double-diaphragm technique proved to be an excellent way to control driver firing pressure using inexpensive diaphragms. No reflected waves from a small high efficiency particulate air filter mounted on the end of the 76-mm-dia shock tube were observed.

HANDLING EQUIPMENT AND PROCEDURES

41409 (LA—6206(Vol.2)(Add.)) **Safety analysis of the Los Alamos critical experiments facility: burst operation of Skua.** Orndoff, J.D.; Paxton, H.C.; Wimett, T.F. (Los Alamos Scientific Lab., NM (USA)). May 1979. Contract W-7405-ENG-36. 32p. Dep. NTIS, PC A03/MF A01.

A detailed consideration of the Skua burst assembly is presented, thereby supplementing the facility safety analysis report covering the operation of other critical assemblies at Los Alamos. As with these assemblies the small fission-product inventory, ambient pressure, and moderate temperatures in Skua are amenable to straightforward measures to ensure the protection of the public.

41410 (NUREG/CR—0796) **Criticality experiments with subcritical clusters of 2.35 wt % and 4.29 wt % ^{235}U enriched UO_2 rods in water with uranium or lead reflecting walls.** Bierman, S.R.; Durst, B.M.; Clayton, E.D. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Mar 1979. Contract EY-76-C-06-1830. 66p. (PNL—2827). Dep. NTIS, PC A04/MF A01.

A series of criticality experiments with 2.35 wt % and 4.29 wt % ^{235}U enriched UO_2 rods in water have provided well defined benchmark type data showing that both depleted uranium and lead reflecting walls submerged in the water reflector, are better neutron reflectors than water alone. For each fuel enrichment the critical separation between three subcritical, near optimally moderated fuel clusters was observed to increase as either 77 mm thick depleted uranium or 102 mm thick lead reflecting walls were moved toward the fuel. The maximum reactivity effect was observed for the depleted uranium with about 20 mm of water between the reflecting walls and the fuel region; whereas, for the lead a maximum effect was obtained with essentially no water between the reflecting walls and the fuel region. This maximum reactivity effect was observed to occur at the same spatial separation between the fuel and reflecting walls for both fuel enrichments. However, the measurements indicated that the magnitude of this phenomenon is dependent on the ^{235}U enrichment of the fuel. The lead reflecting walls increased the critical separation between fuel clusters a maximum of 67% for the 2.35 wt % ^{235}U enriched fuel and at least 152% for the 4.29 wt % enriched fuel. Similar results were observed with the depleted uranium reflecting walls.

MINING AND DRILLING EQUIPMENT AND FACILITIES

REFER ALSO TO CITATION(S) 40280

41411 Independently powered breakout apparatus and method for a sectional drill string. Hodge, L.R.; Crowell, J.M.; Rogers, R.A. (to Hughes Tool Co.). US Patent 4,147,215. 3 Apr 1979. Filed date 9 Mar 1978. 10p.

An improved means for making up and breaking out sections of drill pipe is disclosed herein. The make-up and breakout system is adapted for drill rigs having powered rotaries and powered carriages for moving the rotary up and down the mast. A wrench is mounted to the carriage for gripping the first section of the pipe. Slips are mounted at the work table for gripping the second section of pipe to support the string of pipe and prevent its rotation. The wrench is powered independently of the rotary, and the wrench and rotary can also rotate a certain amount with respect to each other while the wrench is gripping the first section of pipe. The independent power of rotation allows the wrench to breakout the first section from the second section. It also allows the rotary to breakout the first section from the rotary while the wrench restrains the first section from rotation.

41412 Device for supporting, raising and lowering duct in deep bore hole. Johansson, S.H. US Patent 4,141,414. 27 Feb 1979. Priority date 5 Nov 1976, Sweden, 18p.

A duct section or other load to be moved axially along a bore hole has two reciprocating drivers mounted on it and two sets of gripping elements. Each driver reacts axially between the load and a set of gripping elements to move the gripping elements relative to the load through a defined stroke in each axial direction. An endless cable with axially extending straight stretches has one stretch connected to each driver to constrain the drivers always to move in opposite axial directions and to begin and end their strokes simultaneously. The gripping elements are so formed that when engaged with the surface of a bore hole, increasing axial force on the load in one direction increases the radially outward force under which they bite into the surface. At each end of a driver stroke the gripping elements collide with abutment members of a direction control device, whereby gripping elements engaged with the bore hole surface are forced out of such engagement and disengaged gripping elements are forced against that surface. The abutment members are arranged in two sets, one set to coordinate gripping element engagement and disengagement for transporting the load in one axial direction, the other set for transportation in the opposite direction. Positioning the directional control device at one or the other limit of its rotation brings one or the other set of abutment members into use.

LASERS

41413 (AD-A—059959) Potential laser action in he-metal vapor mixtures. Research summary. Leventhal, J.J. (Missouri Univ., St. Louis (USA). Dept. of Physics). 27 Sep 1978. Contract N00014-76-C-0760. 3p. NTIS PC A02/MF A01.

Cross sections for excited state production in ion-molecule collisions have been measured by observing radiation resulting from decay of the excited species. Recent work involving collisions of He(+) or He2(+) with Mg and Zn are discussed.

41414 (AD-A—059969) Water vapor absorption coefficients at HF laser wavelengths. Part I. Atmospheric conditions corresponding to altitudes up to 7 km. Research and development technical report. Watkins, W.R.; Spellicy, R.L.; White, K.O.; Sojka, B.L.; Bower, L.R. (Army Electronics Research and Development Command, White Sands Missile Range, NM (USA). Atmospheric Sciences Lab.). May 1978. 104p. NTIS PC A06/MF A01.

Water vapor absorption measurements are reported at nine HF laser wavelengths ranging from P sub 3-2 (5) at 3418.1600/cm to P sub 1-0 (4) at 3788.2253/cm. The results were obtained with a temperature controlled longpath absorption cell and a path differencing technique with path differences ranging from 8 to 152 m. Cell temperatures ranging from -18 to 25 C were used. Pure water vapor as well as air (N2/O2) broadened water vapor absorptions were measured for pressures ranging from less than 1 torr to 764 torr. Limited data on O2 broadened water vapor absorption as well as pure and air broadened CO2 absorption are presented. In general the air broadened water vapor results show more absorption than predicted and imply a 'super' Lorentz or Voigt line shape. The pure O2 broadened water vapor absorption is less than the air broadened absorption. New self- and foreign-broadening coefficients are obtained. Finally, the limited CO2 absorption observed shows good agreement with theoretical predictions. These results will allow more accurate modelling of atmospheric transmission for EO and HEL applications. (Author)

41415 (N—79-10881) Photon reflection at the boundary of an inverted medium. Lawandy, N.M. (National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center). Aug 1978. 13p. NTIS PC A02/MF A01.

The index change near a quantum transition is shown to cause significant feedback into a gain medium. Criteria are given for the onset of self-lasing in an extended material. The distortion of a reflected pulse is also considered.

41416 Alkali-metal resonance-line lasers based on photodissociation. Ehrlich, D.J.; Osgood, R.M. Jr. (Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Massachusetts 02173). *Appl. Phys. Lett.;* **34**: No. 10, 655-658(15 May 1979).

We report on a series of new lasers involving transitions in Na, K, Rb, and Cs. Pulsed output powers of 1—10 kW have been obtained on the alkali-metal resonance lines. Details of the photodissociative excitation process have been studied in order to optimize these lasers.

41417 Longitudinal-mode control of a CO_2 TE laser by means of intracavity absorbers. Dougal, R.A.; Jones, C.R.; Gundersen, M.; Nelson, L.Y. (Texas Tech University, Department of Electrical Engineering, Lubbock, Texas 79409). *Appl. Opt.;* **18**: No. 9, 1311-1313(1 May 1979).

Single longitudinal mode output of a pulsed TE CO_2 laser has been obtained using several different intracavity gas-phase absorbers. The method described is simple and inexpensive and appears to be extremely general.

41418 Resonator configuration for the suppression of relaxation oscillations in a long-pulsed Nd:YAG laser. Sandoval, R.P. (Sandia Laboratories, Albuquerque, New Mexico 87185). *Appl. Opt.;* **18**: No. 9, 1328-1333(1 May 1979).

A resonator configuration which couples out the Gaussian TEM_{00} mode was demonstrated to suppress low-frequency relaxation oscillations in the output from a long-pulse Nd:YAG laser. Experimental measurements of the spatial and temporal beam quality, the spectral bandwidth, and the depth of amplitude modulation were made for this and several other Nd:YAG laser resonator designs. The result of these measurements indicates that this resonator configuration can be used to generate a high-quality (TEM_{00}) long-pulse laser output which is nearly free from relaxation oscillations.

41419 On-resonant phase-conjugate reflection and amplification at 10.6 μm in inverted CO_2. Fisher, R.A.; Feldman, B.J. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Opt. Lett.;* **4**: No. 5, 140-142(May 1979).

We have obtained phase-conjugate reflection and amplification with an effective reflectivity exceeding unity by redirecting the output of a TEA CO_2-laser oscillator into its own gain medium. The intense counterpropagating waves within the laser coupled through the saturated gain medium to provide the nonlinearity in a process analogous to degenerate four-wave mixing.

41420 Tripling of CO_2 laser frequency in deuterium chloride gas. Kung, R.T.V.; Mani, S.A. (Avco Everett Research Laboratory, Inc., Everett, Massachusetts 02149). *J. Appl. Phys.;* **50**: No. 4, 2548-2551(Apr 1979).

The generation of third-harmonic radiation from the 9.6-μm P (22) CO_2 laser line was investigated in DCl (deuterium chloride). A total of 11 conversion efficiency maxima were observed up to a pressure of 28 atm. The measured index mismatch (n_3-n_1) between the third harmonic and the fundamental frequencies is 4 x 10^{-6}/atm. This compares favorably with the calculated index mismatch of 3.6 x 10^{-6}/atm. It is found that the major contribution to n_3-n_1 arises from the far-infrared pure rotational transitions. The measured chi/sup(3) was deduced from experimental results and shown to agree with calculated values to a factor of 2.

41421 High-power TEM_{00} tunable laser system. Mahon, R.; McIlrath, T.J.; Koopman, D.W. (University of Maryland, Institute for Physical Science and Technology, College Park, Maryland 20742). *Appl. Opt.;* **18**: No. 6, 891-896(15 Mar 1979).

A 45-MW, 25-nsec duration, tunable laser operates in the near-ir and can be frequently-doubled to produce a 20-nsec duration uv output of 7.5 MW. The additional feature of a near single spatial mode makes this laser a tunable source of exceptional brightness. The beam diameter and divergence are substantially influenced by the spatial gain profile of the oscillator dye medium, by the ability to pump uniformly the dye amplifiers and, for the uv light, by the stringent angular sensitivity of the frequency-doubling crystal.

41422 Gas laser device. Godard, B.; Gaffard, J.P. (to Compagnie Generale d'Electricite S.A.). US Patent 4,143,338. 6 Mar 1979. Priority date 7 Jan 1976, France, 6p.

The gas laser device includes, in succession along an optical axis, a gas laser excited by a traveling wave, a convergent lens, two parallel-sided optical prisms adhering to one another in a symmetrical position in relation to the axis, and another convergent lens. The arrangement is such that two divergent elementary beams produced by the laser are brought together to have substaintially less divergence.

41423 Method of pumping. Beaulieu, J. (to Minister of National Defence). US Patent 4,143,337. 6 Mar 1979. Priority date 19 Apr 1968, Canada, 10p.

A CO_2 gas laser is disclosed which is capable of operation at or above atmospheric pressure and requires no windows or evacuation system. Substantial increases in power output, simplicity, and cheapness are achieved.

41424 Xenon bromide (XEBR) excimer laser. Searles, S.K.; Hart, G.A. (to Secretary of the Navy). US Patent 4,143,336. 6 Mar 1979. Filed date 3 Mar 1976. 4p.

A xenon bromide (XeBr) excimer laser is made by electron beam excitation over a range of from 10 to 3000 torr xenon with 0.5 to 4% Br_2. Xe* generated by a high-energy electron beam reacts with Br_2 to produce XeBr which undergoes a bound-free transition resulting in stimulated emission on the transition $XeBr^* \rightarrow Xe + Br + h\nu$ (230 to 360 nm) where* represents a low lying electronically excited state.

41425 Flashtube-pumped photodissociation laser with improved characteristics. Belousova, I.M.; Danilov, O.B.; Zhevlakov, A.P.; Kiselev, V.M. *Sov. J. Opt. Technol. (Engl. Transl.);* **45**: No. 10, 628-631(Oct 1978).

A flashtube-pumped photodissociation laser is described that has a 330-J emission energy in one spectral component with a width of 0.05 A and an efficiency of 0.4%. The possibility of spatial stabilization of the lasing zone of such a laser is shown.

41426 Flashlamp-excited photodissociation 1000 J laser with 1.4% efficiency. Antonov, A.S.; Belousova, I.M.; Gerasimov, V.A.; Danilov, O.B.; Zhevlakov, A.P.; Sapelkin, N.V.; Yachnev, I.L. *Sov. Tech. Phys. Lett. (Engl. Transl.);* **4**: No. 10, 459(Oct 1978).

A high energy photodissociation laser is described which is pumped by a high-power flashlamp within the working medium. The laser efficiency of 1.4% indicates full conversion of the energy radiated by the lamp in the working gas absorption band into laser radiation. (AIP)

41427 Semiconductor laser with composite waveguide. Karpov, S.Y.; Kuchinskii, V.I.; Portnoi, E.L. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **4**: No. 10, 464-465(Oct 1978).

A leaky waveguide laser configuration is considered which uses an active gain region and a passive radiating region, independent of each other. End excitation of leaky modes makes possible a highly collimated coherent beam with a weak isotropic radiation background. (AIP)

41428 Bias quenching of relaxation oscillations in an injection laser. Eliseev, P.G.; Lavrov, V.N.; Morozov, V.N. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **4**: No. 10, 466-467(Oct 1978).

It has been suggested, based on integration of the rate equations, that relaxation oscillations which affect the modulation characteristics of semiconductor injection lasers can be quenched by photon injection from external sources. In the present experiments these oscillations are quenched without using optical systems. (AIP)

41429 Passive Q switching of a neodymium-garnet laser at 1.3 μ. Batashev, S.P.; Bezlepko, E.V.; Lebedev, O.L.; Luk'yanets, E.A.; Mekhryakova, N.G.; Mizin, V.M.; Petukhov, V.A. *Sov. Tech. Phys. Lett. (Engl. Transl.);* **4**: No. 10, 485(Oct 1978).

Laser action and passive Q switching at 1.3μ in the neodymium:YAG laser are reported. Discrimination against the 1.06 μ transition is achieved by use of an additional cell containing dense solutions of dyes having strong electronic absorption at 1.06 μ and weak absorption at 1.3 μ. (AIP)

41430 Barium-vapor laser with a high average output power. Bokhan, P.A.; Solomonov, V.I. (Institute of Atmospheric Optics, Siberian Branch, Academy of Sciences of the USSR, Tomsk). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **4**: No. 10, 486-487(Oct 1978).

The use of double and triple pulses, in barium vapor lasers, to study the output energy in the second and third pulses as a function of the time delay between pump pulses is reported. To raise the average power, improved discharge tube cooling is necessary as well as development of a pulse generator of adequate power at a repetition frequency above 100kHz. (AIP)

41431 Reduction of the number of longitudinal modes in a cw neodymium garnet laser. Evtyukhov, K.N.; Kaptsov, L.N. *Sov. Tech. Phys. Lett. (Engl. Transl.);* **4**: No. 10, 487-488(Oct 1978).

Estimation of the number and power levels of longitudinal modes in a cw neodymium garnet laser is demonstrated. The calculation is based on the fact that the steady-state standing waves generated in the cavity must cause the most uniform reduction of population inversion in the crystal. (AIP)

41432 Chemical cw CO laser with a mixture of air and carbon disulfide. Dudkin, V.A.; Rukhin, V.B. (Institute of Problems of Mechanics, Academy of Sciences of the USSR, Moscow). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **4**: No. 10, 490-491(Oct 1978).

The effect of air upon the operation of a carbon monoxide chemical laser using a carbon disulfide flame is studied. It is shown that the highest laser output power is obtained with a ternary mixture. (AIP)

41433 Increased efficiency of a transverse-discharge XeF laser. Isakov, I.M.; Leonov, A.G.; Ogluzdin, V.E. (Scientific-Research Institute of Nuclear Physics, M. V. Lomonosov Moscow State University). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **4**: No. 10, 493-494(Oct 1978).

The effect of UV preionization on the output characteristics of XeF excimer lasers pumped by fast transverse discharges id reported. With UV preionization the main discharge output energy is five times more than without preionization. (AIP)

41434 Self-locking of longitudinal modes in a cw linear Nd^{3+}:YAG laser. Gusev, A.A.; Kruzhalov, S.V.; Pakhomov, L.N.; Petrun'kin, V.Y. (M. I. Kalinin Leningrad Polytechnical Institute). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **4**: No. 10, 503(Oct 1978).

Experimental observations of longitudinal mode self-locking in a cw linear Nd^{3+}:YAG laser with an 80 cm long cavity are reported. If selective elements are eliminated and the laser operated under polarized mode conditions, longitudinal mode self-locking is easily achieved with cavities of ordinary length. (AIP)

41435 Composite tunable laser at 1.89, 3.39, and 16 μ. Grasyuk, A.Z.; Karev, Y.I.; Losev, L.L.; Smirnov, V.G. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **4**: No. 10, 504-505(Oct 1978).

The development of a pulsed laser, tunable near 1.89, 3.39 and 16 μ, which uses stimulated Raman scattering of the output of a neodymium-glass laser in compressed gaseous hydrogen and liquid nitrogen is reported. The tuning range at each Stokes component is 60 cm^{-1}. (AIP)

41436 Breakdown in a CO_2 photoionization laser: effect on output. Galaktionov, I.I.; Gorelov, V.Y. *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **23**: No. 10, 1224-1225(Oct 1978).

The operation of a CO_2 photoionization laser is studied in the ionization-amplification mode with $E/N=5x10^{-16}$ Vxcm². The breakdown which occurs at a pumping level of 350 J/(literxatm) when power is obtained from a 0.67-μF capacitor shields part of the active volume because of absorption due to free—free electron transitions in the ion fields. Reducing the capacitance to 0.33 μF, which reduces the pump level by 25%, makes it possible to avoid breakdown and to raise the output energy to 12.5 J. When breakdown is avoided the efficiency is increased to 35—40%. Images of the evolution of the breakdown channels are discussed.

41437 High-pressure CO_2 laser with a cascade discharge. Rubinov, Y.A.; Mazurenko, Y.T. *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **23**: No. 10, 1226-1228(Oct 1978).

An atmospheric-pressure CO_2 laser with a "cascade discharge" and two radiating volumes is described. The emission energy is distributed discretely over two regions of the beam cross section, and the energy is emitted from the two regions in succession with a delay that reaches 10 μsec. The laser can operate in two modes: volume pumping or electron cathode pumping. The region in which a homogeneous discharge exists is found in a plot of the capacitance of the storage bank against the bank voltage. The effect of the preionization mechanism on this homogeneous region is studied.

41438 CO laser pumping with high-energy particles. Gudzenko, L.I.; Malyshevskii, V.S.; Yakovlenko, S.I. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **23**: No. 10, 1228-1231(Oct 1978).

Pumping a dense gas with high-energy particles (electrons or fission fragments) is analyzed. This mechanism favors emission associated with vibrational transitions. Energy is transferred from the high-energy particles to free electrons as the gas is ionized; the energy is then transferred from the free electrons to molecular vibrations. The case of pure carbon monoxide is analyzed.

41439 Diffusion, heat-pumped D_2—HCl—Ar and D_2—HCl—He gasdynamic lasers. Gavrikov, V.F.; Oraevskii, A.N.; Piskunov, A.K.; Rodionov, N.B.; Shcheglov, V.A. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **4**: No. 9, 415-416(Sep 1978).

A numerical solution study of diffusion heat-pumped gasdynamic lasers using deuterium and either argon or helium is reported. The gain of the gas flow when molecular HCl is added to a supersonic deuterium flow in a low temperature flow region is calculated; also studied is the effect of HCl molecule anharmonicity on the active medium gain.(AIP)

41440 Tunable solid-state laser with a microcomposition matrix active medium. Dul'nev, G.N.; Zemskii, V.I.; Krynetskii, B.B.; Meshkovskii, I.K.; Prokhorov, A.M.; Stel'makh, O.M. *Sov. Tech. Phys. Lett. (Engl. Transl.);* **4**: No. 9, 420(Sep 1978).

The use of a microcomposition matrix material, quartz and one or more dyes, as an active laser medium is reported; the conditions are such that the dye displays photochromism. Tests over the course of seven hours showed no appreciable degradation of the laser material indicating the first development of a tunable pulsed solid-state laser with a long service life.(AIP)

41441 Minimum line width of an injection laser. Velichanskii, V.L.; Zibrov, A.S.; Kargopol'tsev, V.S.; Molochev, V.I.; Nikitin, V.V.; Sautenkov, V.A.; Kharisov, G.G.; Tyurikov, D.A. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **4**: No. 9, 438-439(Sep 1978).

Experimental confirmation is presented of the idea that quantum noise determines the line width lower limit in a semiconductor laser in single-frequency operation. The width of the output line has been measured, for the first time, using beats between two tunable semiconductor lasers.(AIP)

41442 Increased lifetime of the active medium of a pulsed N_2O gasdynamic laser. Testov, V.G.; Grin', Y.I.; Mishin, G.I.; Petrov, R.L.; Menenkov, V.D. (Institute of Radio Engineering and Electronics, Academy of Sciences of the USSR, Moscow and A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **4**: No. 9, 449-450(Sep 1978).

Experiments are described in which the lifetime of the active medium at the nozzle end of a gas dynamic pulsed laser is substantially increased for an optimum gas mixture. In these experiments the lifetime of the laser mixture is 4.5—7.5 msec in contrast to previous experiments where the lifetime has been less than 2—3 msec.(AIP)

41443 Study of the spatial characteristics of the output from pulsed lasers with a FTIROS material. Zakharchenya, B.P.; Terukov, E.I.; Chudnovskii, F.A.; Shteingol'ts, Z.I. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **4**: No. 9, 456(Sep 1978).

The spatial distribution of energy density in beams from ruby and neodymium pulsed lasers is studied using a "FTIROS" material ("phase-transformation interference reversible light reflector"). The spatial distribution is found to be much more homogeneous for the neodyhium-glass laser than for the ruby laser.(AIP)

41444 System efficiencies of CO electric discharge lasers. Takano, K.; Masuda, T.; Onda, K. *Denki Shikensho Iho;* **42**: No. 9, 20-40(Sep 1978). (In Japanese).

Three closed-cycle systems of electric discharge CO lasers were studied to calculate the system efficiency: the ratio of laser output to the electrical input to the system; in consideration of the refrigerator power, compresson power and various kinds of losses. The system efficiency of a conventiaonal discharge laser and that of a forced convection laser are 17 and 7% respectively, which are comparable to those of CO_2 laser systems. Large refrigerator power decreases the system efficiency. The system efficiency of apostexpansion excitation CO laser becomes greater with increase of laser output. The system efficiency of 10MW CO laser is .

41445 Coherence oscillations in nonlinear media and the lifetime of a coherent state. Eimerl, D. (Univ. of California, Livermore). Contract W-7405-ENG-48. *Opt. Commun.;* **25**: No. 2, 277-278(May 1978).

It is shown that in a medium with a nonlinear index of refraction, a mode of the electromagnetic field has only zeroth order coherence. The energy in the mode is not proportional to the semiclassical intensity, absolute value E^2. The ratio absolute value E^2/I oscillates with a frequency proportional to n_2, which is, however, very small. 7 references.

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 40243, 40244, 40876, 40877

41446 (BNL-NUREG—25616) One-dimensional model of vapor generation in steady flashing flow. Wu, B.J.C.; Saha, P.; Abuaf, N.; Jones, O.C. Jr. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 11p. (CONF-790602—6). Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; Atlanta, GA, USA (3 Jun 1979).

In order to predict the critical flow rates of a vapor-liquid two-phase mixture through pipes discharging into a low pressure environment, it is necessary to understand the characteristics of a flashing two-phase mixture. Of particular importance is the transition from single-phase (liquid) to two-phase flow as a result of rapid depressurization of the liquid in the flow causing the liquid to vaporize or flash. Results of a series of flashing experiments performed by Reocreux (1974) are available in the literature. The nonequilibrium vapor generation model developed at BNL is discussed, and the application of this model to the evaluation of Reocreux's experiments is presented.

41447 (FE—2556-17) Development of a ceramic tube heat exchanger with relaxing joint. Interim technical progress report, January 1977—May 1978. Ward, M.E.; Napier, J.C. (Solar Turbines International, San Diego, CA (USA)). 15 Jun 1978. Contract EF-77-C-01-2556. 292p. Dep. NTIS, PC A13/MF A01.

Three tube materials were selected as primary candidates for the ceramic heat exchanger test module. These materials (α-sintered silicon carbide, Carborundum; sintered silicon carbide, NC 430, Norton; Super KT silicon carbide, Carborundum) were evaluated. Radial compression tests on all of the above materials were completed. Strength data are statistically recorded in this report. None of the ceramics tested has sufficient strength to be used without thermal expansion provision between the ceramic tubes and metal shell (strengths above 100 ksi are required), and tubes conncected to the same heater (strengths above 20 ksi are required). All of the materials tested to date were impermeable to air at 100 psi and temperatures up to 1600°F. Environmental rig tests of KT silicon carbide tubes with Homer City flyash at an air temperature of 1260°C (2300°F) and 1037°C (1900°F) and a tube temperature of 1148°C (2100°F) and 871°C (1900°F) were completed. Three distinct temperature zones were identified in tube rig tests for the Homer City power plant flyash; nonsticking, sticking and flyash melt-off. Gas tight permanent joints have been made and have completed up to 50 hours of endurance testing at pressure and temperature. A ceramic to metal spherical compression joint has been designed and tested at 704°C (1300°F) with an internal gas pressure of 80 psig and endload of 20 kg (44 lbs) for 25 hours without leakage. Design of a counteraxial flow tube and shell heat exchanger has been completed and construction started. The new improved relaxing glass joint will be incorporated into the module during the module's test program.

41448 (FE—2700-6) Heat transfer in a fluidized counter current bed. Quarterly report, November 1978—February 1979. Jackson, R. (Houston Univ., TX (USA)). Mar 1979. Contract EF-77-S-01-2700. 19p. Dep. NTIS, PC A02/MF A01.

An apparatus has been designed and constructed to investigate the downflow of larger and/or denser particles through a fluidized bed of smaller and/or less dense particles. An investigation of the influence of bed depth, bed expansion, feed rate of the descending particles and descending particle size on the holdup of the descending particles in a 4 in. diameter bed has now been completed. The maximum attainable feed rate of the dense particles, limited by "flooding", has been related to bed expansion, bed depth, and the size of the descending particles. Additions to the test rig needed to measure heat transfer rates from the descending particles to the bed have been completed, and one such set of measurements has been made for the system lead shot - polystyrene beads.

41449 Heat emission crisis in annular ducts with turbulators during even and uneven on-line evolution. Ornatskii, A.P.; Chernobai, V.A.; Vasil'ev, A.F.; Furaev, V.S. *Teplofiz. Teplotekh.;* No. 34, 13-17(1978). (In Russian).

Results are given for experimental studies of heat emission crisis and hydraulic resistance in smooth annular ducts with semiannular protuberances or recesses on the unheated surface in the case of even and uneven laws of online heat evolution. A turbulator apparatus in the form of semiannular protuberances leads to 1.2 to 1.5 increase in the critical capacity when the hydraulic resistance of the duct is increased from 20 to 40%.

41450 (NUREG/CR—0648) Measurement of phase velocities in mist flows using stagnation probes. Fincke, J.R.; Deason, V.A. (Idaho National Engineering Lab., Idaho Falls (USA)). Mar 1979. Contract EY-76-C-07-1570. 41p. (TREE—1350). Dep. NTIS, PC A03/MF A01.

Modeling techniques describing the behavior of a combination gas phase and total flow stagnation probe in mist flows are discussed. Details of techniques required to determine local phase velocities and drop size are presented along with a sampling technique for obtaining liquid flow rate. Requirements for the successful probe design are discussed. The details of operation in steady state flows are given, as well as recomendations concerning extrapolation to transient flows. Experimental results obtained in steady state air-water mist flows are detailed. The ratio of mass flow rate of gas to liquid was varied from 1.0 to 8.0, and the superficial gas velocity was varied from 35 to 80 m/s. Flow regimes covered are annular mist, dispersed mist, and stratified mist. Local slip ratios between 1.0 and 6.0 were measured, with most measured slip ratios lying between 1.0 and 2.0.

41451 (SAND—79-0209C) Variable grid scheme for discontinuous grid spacing and derivatives. Blottner, F.G. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 16p. (CONF-790614—2). Dep. NTIS, PC A02/MF A01.

From National computer conference 1979; New York, NY, USA (4 Jun 1979).

In a previous paper, a Crank-Nicolson scheme with a variable grid was developed for solving turbulent boundary layer flows. It was demonstrated that this method is second-order accurate if the grid is specified with a smooth analytical expression; as the grid is refined according to this expression, the numerical error decreases as the square of the reciprocal of the number of mesh intervals employed. Although this approach is adequate for many problems, there are cases where a discontinuous change in mesh size is more convenient. In addition, there are problems where the derivative of the dependent variable is discontinuous and the previous Crank-Nicolson scheme is inappropriate. The discontinuous derivative can

occur as the result of using different coordinate transformations for various regions of a flow problem. If the coefficients in the governing equations are discontinuous, the derivative of the dependent variable is also discontinuous. This type of problem occurs when a boundary layer flow of gas over a liquid layer is solved as one problem. This investigation was concerned with an extension of the Crank-Nicolson approach to cases where the grid spacing is arbitrary and discontinuous, and has resulted in a new Crank-Nicholson type finite difference scheme. The important conclusions about the method are: only certain second-order accurate relations for determining the wall velocity gradient should be used in evaluating the accuracy of the scheme; second-order behavior of this scheme can be retained on grids with discontinuous spacing; and the method developed can be readily applied to problems with discontinuous derivatives.

41452 Spectral decomposition in advection-diffusion analysis by finite element methods. Nickell, R.E.; Gartling, D.K. (Sandia Labs., Albuquerque, NM). *Comput. Methods Appl. Mech. Eng.;* 17/18: 561-580(Mar 1979).

A spectral decomposition method based upon finite element modeling is compared to a Crank-Nicolson direct integration solution scheme and the exact solution for the one-dimensional, nonlinear system defined by Burger's equation. Results from this study are applicable to both fluid mechanics and combined conduction-convection heat transfer. The parameter α, which governs the importance of diffusive transport, was varied over a sufficiently wide range such that comments on the comparisons are general. The mode superposition method proved to be very attractive in comparison to the second-order accurate Crank-Nicolson approach, generally allowing an order of magnitude larger time step for equivalent convergence to the exact solution. The modal shapes themselves tend to provide useful information about the ability of a given mesh to produce accurate results, much in the same way that modal information is used in nonlinear structural dynamics. For this class of problems, in contrast to structural dynamics, system nonlinearities did not manifest themselves in dramatic changes in the eigenspectrum.

41453 Numerical method for predicting natural convection in horizontal cylinders with asymmetric boundary conditions. Kee, R.J. (Sandia Labs., Livermore, CA); McKillop, A.A. *Comput. Fluids;* 5: No. 1A, 1-14(1977).

A numerical technique is developed to predict the two-dimensional transient natural convection heat transfer within a horizontal cylinder. Finite difference analogs of the Navier—Stokes and thermal energy equations are solved in the stream function-vorticity framework. The solution method, which is a modification of an alternating-direction implicit (ADI) scheme wherein the convective terms are evaluated explicitly, is found to be computationally more efficient than either an ADI or an explicit method. Unlike previous work, the present technique will accommodate completely arbitrary temperature boundary conditions. Thus, rather than considering an annular space or half of a symmetric cylinder, the solutions are determined for a full cylinder. A Cartesian form of the governing equations is employed at the point $r = 0$ where the polar coordinate equations become singular. The computed results are found to be in good agreement with previously published experimental data.

MATERIALS TESTING

REFER ALSO TO CITATION(S) 40788

41454 (ANL/MSD—79-2) **Nondestructive evaluation techniques for high-temperature ceramic components. Sixth quarterly report, January—March 1979.** (Argonne National Lab., IL (USA)). Apr 1979. Contract W-31-109-ENG-38. 18p. Dep. NTIS, PC A02/MF A01.

Tests comparing the effectiveness of radiographic and conventional ultrasonic techniques have shown that dye-enhanced neutron- and x-radiography techniques are capable of revealing surface flaws (in this case, small dents in a silicon nitride bar) which cannot be revealed by conventional radiographic or ultrasonic means. These results support the idea that dye-enhanced radiography may be useful for detection of flaws on surfaces not accessible for conventional dye-penetrant examination. A small ($\sim$ 100 x 50-μm) "crack" was made on the surface of a hot-pressed silicon carbide bar and various techniques were used in an attempt to detect it. Dye-penetrant, ultrasonic and radiographic techniques were not capable of detecting this flaw. Holographic-interferometry methods (with the bar stressed in a four-point bending fixture) were barely adequate to reveal the presence of the flaw. However, the Sonoscan acoustic microscope was able to detect the flaw unambiguously, via mode-converted surface waves scattered backwards from the flaw. Progress has been made in the development of a stage to be used with the acoustic microscope for demonstrating the feasibility of helically scanning SiC heat-exchanger tubing. Also, some apparatus has been acquired for demonstrating the adequacy of ultrasonic bore-side inspection of SiC tubing.

41455 Making mica retardation plates: a simple technique. Chu, S.; Conti, R.; Bucksbaum, P.; Commins, E. (University of California, Lawrence Berkeley Laboratory, Materials Molecular Research Division and Physics Department, Berkeley, California 94720). *Appl. Opt.;* 18: No. 8, 1138-1139(15 Apr 1979).

SAFETY ENGINEERING

REFER ALSO TO CITATION(S) 41389

ELECTRONIC CIRCUITS AND DEVICES

REFER ALSO TO CITATION(S) 41575

WASTE PROCESSING PLANTS AND EQUIPMENT

41456 Feasibility of cotreatment of municipal solid waste and sewage sludge in Boston, Massachusetts. Stone, R.C. (Stone and Webster Engineering Corp., Boston, MA); Forzley, V.G.; Blank, L.; Weiss, M. pp 147-155 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

Results show that cotreatment of municipal solid waste and sewage is technically and environmentally feasible based on 1500 TPD of solid waste and 428 TPD of dewatered sludge. The annual operating cost of a single cotreatment facility is less than the cost of separate treatment facilities. However, since the MDC sludge management plan is eligible for full Federal and state water pollution control grants in the order of 30 million dollars, and a cotreatment faciity would be eligible for only 13 million dollars, separate waste disposal plans are more economical in Boston than cotreatment. Only if all of the capital grants which the MDC sludge plan is eligible for were available for the cotreatment facility, would cotreatment be preferred waste disposal plan. This study indicate that if sludge transportation is excluded from the economic analysis, cotreatment would be preferred both without and with capital grants. Another important consideration, which has a significant impact on the viability of a site, is a continuous market for the by-product energy. If due to the lack of a steam market electric power is produced, the value of this product should be determined at an early stage with the electric utility.

COMBUSTION SYSTEMS

REFER ALSO TO CITATION(S) 40054, 40062, 40131, 40172, 40173, 40195, 40196, 40197, 40198, 40199, 40204, 40206, 40207, 40208, 40209, 40210, 40211, 40212, 40213, 40214, 40215, 40233, 40234, 40235, 40237, 40238, 40240, 40246, 40247, 40251, 40252, 40255, 40257, 40258, 40259, 40260, 40261, 40262, 40263, 40264, 40266, 40267, 40782, 40797, 40798, 40800, 40801

41457 (ANL/EES-TM—46) **Pulse combustion technology for heating applications. Quarterly progress report, January 1 to March 31, 1979.** Ahrens, F.W.; Clinch, J.M.; Egbert, H.P. (Argonne National Lab., IL (USA)). May 1979. Contract W-31-109-ENG-38. 17p. Dep. NTIS, PC A02/MF A01.

The primary purpose of this program is to develop design data and procedures for pulse combustion burners. The program will thus contribute to the accelerated industrial development of cost-effective, high-efficiency systems for a variety of heating applications. The major program tasks are designated as: burner performance studies, burner noise studies, and evaluation and application. Progress in these areas for the period January 1, 1979 to March 31, 1979 is reported.

41458 (M—78-68(Vol.2), pp 44-59) **Comparison of industrial and utility fluidized bed combustion boiler design considerations.** Smith, J.W. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

This paper provides a comparison of FBC boilers with conventional stoker and pulverized coal fired boilers in the areas of

combustion efficiency and emission characteristics. The utility and industrial application of FBC boilers are contrasted in the areas of size, steam conditions, load response and evaluation factors.

41459 (M—78-68(Vol.2), pp 61-89) **Industrial application fluidized bed combustion, Georgetown University.** Buck, V.; Wachtler, F.; Tracey, R. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

On June 30, 1976, ERDA selected Georgetown University as the prime contractor and the Georgetown campus as the site for a coal fired, industrial/institutional size,atmospheric fluidized-bed boiler. The contract provides for the development and construction of an addition to the existing central heating plant. The 100,000 pound per hour boiler will supply the university's steam distribution system meeting the changing load conditions of a University complex. As of December 1977, construction was underway and all major contracts had been awarded. Construction completion and start of operation was scheduled for February 5, 1979. Presented are the program objectives, descriptions of the fluidized-bed boiler and plant arrangement, and progress to date in design and construction activities at Georgetown.

41460 (M—78-68(Vol.2), pp 91-105) **Fluidized bed combustor for small industrial applications.** Hanson, H.A.; DeCoursin, D.G.; Kinzler, D.D. (FluiDyne Engineering Corp., Minneapolis, MN). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The project, sponsored by DOE, is to design, construct, and operate an atmospheric fluidized bed combstion (FBC) air/hot water heater and distribution system. The system will supply hot, low pressure air and hot water to meet the space heating and process needs of a manufacturing plant. The demonstration facility will be located at Owatonna Tool Company (OTC) in Owatonna, Minnesota, and will handle the load fluctuations in this 265,0000 ft^3 plant and office complex, which employs 1100. This plant site provides an opportunity to demonstrate and study the operation and interfacing of an FBC into existing systems and plant equipment in a variety of typical manufacturing operations. Many industrial companies require clean, hot gases and/or hot liquids in their manufacturing and production processes. The long term objective of the OTC project is to demonstrate that coal-fired FBC heating can economically meet these needs. The total system heat load varies from 1 x 10^6 Btu/hr to 28 x 10^6 Btu/hr depending on season and time of day.

41461 (M—78-68(Vol.2), pp 191-201) **First performance results from the Rivesville multi-cell fluidized bed boiler.** Claypoole, G.; Hill, D.; Mineo, R. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Operating results to date would be more complete if it had been possible to avoid all of the usual startup problems. Generally, these problems affected non-AFB process equipment such as control valves, circulating pump seals, fans and electrical equipment. A very positive result of encountering problems has been the response of the boiler to an emergency fuel trip-out. The ability of the control system, boiler, and operators to respond to an emergency situation is illustrated. It is noted that the boiler evaporation was restored to original conditions in 45 minutes. The MFB is instrumented to a level necessary to operate the unit, but inadequately for the purposes of detailed results gathering and performance analysis. Within the limitations of availability and instrumentation, a series of "performance runs" have been made and reduced. These preliminary tests were aimed at preliminary evaluation of the following parameters of the MFB: combustion efficiency, boiler efficiency, sulfur capture, SO_2 and NO/sub x/ emission levels, particulate emission, and rate of dust elutriation.

41462 (M—78-68(Vol.2), pp 223-237) **Lightoff of multicell fluidized bed boilers by hot bed transfer.** Gasner, L.L. (Univ. of Maryland, College Park); Turek, D.; Aulisio, C.; Hill, D. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Lightoff by hot bed transfer has been demonstrated to be a successful lightoff procedure for multicell, atmospheric, fluidized-bed boiler operation. The routine successive cell lightoff in the 30 MWe Rivesville Multicell AFBC boiler has been very successful. Raw data from this effort has been used to develop a correlation believed useful to predict successive cell lightoff by hot bed transfer. Bed height, pressure drop, temperature and time to coal ignition calculation methods are presented along with correlations to large scale data. The above correlation has also been extended to the simultaneous lightoff of two successive cells in series.

41463 (M—78-68(Vol.2), pp 267-283) **Application of atmospheric fluidized bed combustion for electric power generation.** Becker, T.W. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The application of fluidized bed combustors in the utility industry is a potential alternate method of utilizing high sulfur coals for electrical power generation in an environmentally acceptable manner. The Babcock and Wilcox Co., under contract to Stone and Webster Corporation for the Department of Energy, has developed a conceptualized design for a 570 MW atmospheric pressure fluidized bed boiler (AFB). This paper presents the design of the AFB boiler and associated equipment. In addition, recommendations for a boiler design for a 200 MW demonstration plant are presented.

41464 (M—78-68(Vol.2), pp 285-311) **Conceptual design of a Foster Wheeler Energy Corporation atmospheric fluidized bed steam generator for Stone and Webster Engineering Corporation and Tennessee Valley Authority.** Reed, K.A.; Cervenka, G.G. (Foster Wheeler Energy Corp., Livingston, NJ). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Foster Wheeler is presently engaged in contracts sponsored through the Department of Energy and Tennessee Valley Authority for conceptual design studies with budget estimates for commercial application atmospheric fluidized bed steam generators. A contract through Stone and Webster Engineering Corporation is directed toward comparaison of design and costs for a 570 MW atmospheric fluidized bed unit with a similar size pulverized coal unit. A contract through Fluidized Combustion Company for Tennessee Valley Authority is directed toward a 150 MW demonstration size atmospheric fluidized bed unit with a scale up to a 600 MW commercial size unit. Design considerations, equipment and subsystem selection rationale are represented. The primary advantages of a fluidized bed steam generator over an equivalent size pulverized coal fired unit, are as follows: reduced SO_2 emissions, reduced NO/sub x/ emissions, reduced steam generator heat transfer surface, elimination of a flue gas scrubbing system, elimination of the coal pulverizing system, and insensitivity to varying fuel characteristics. It is the purpose of this paper to present a viable design in which the process may be applied to a utility installation for generation of steam to produce electricity.

41465 (M—78-68(Vol.2), pp 313-324) **Conceptual design and preliminary evaluation of a 570 MW electric power generating plant using a Babcock and Wilcox Company or a Foster Wheeler Energy Corporation atmospheric fluidized-bed boiler.** Lipari, P.F.; Wells, T.G. Jr. (Stone and Webster Engineering Corp., Boston, MA). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

In January 1977, a contract for a conceptual design of a commercial size steam electric power generating plant utilizing an AFB boiler was awarded by DOE/ERDA to Stone and Webster Engineering Corporation in conjunction with Pope, Evans and Robbins, Inc. The project approach was to use a pulverized coal with wet scrubber power generating facility currently being designed, as a base plant, and to then substitute AFB boilers as designed by boiler manufacturers, for the PC boiler and scrubbers and determine the technical and economical feasibility of such designs. To accomplish this goal, two major boiler manufacturers, i.e. Foster Wheeler Energy Corporation and Babcock and Wilcox were awarded contracts to design 570MW AFB boilers. For the purpose of this study, the scope of work by the boiler manufacturers was expanded to include bunkers, draft equipment, particulate collection equipment and combustion controls. The AFB plant design is a duplicate of the PC plant Stone and Webster Engineering Corp. is designing for a utility client. All plant design parameters, fuel and limestone characteristics, and economic factors are the same for both designs to allow direct comparison.

41466 (M—78-68(Vol.2), pp 326-341) **Conceptual design of a 570-MW Combustion Engineering, Inc. atmospheric fluidized bed steam generator.** Covell, R.B. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Combustion Engineering's approach to the conceptual designing of an atmospheric fluidzed-bed steam generator is described, including selection of bed design characteristics, unit physical arrangement and other design features. Also described are auxiliary equipment and unit design performance.

41467 (M—78-68(Vol.2), pp 343-353) **Conceptual design of an AFBC electric power generating plant.** Bradley, W.J. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The generating costs analysis shows a 4% advantage of the AFBC plant over the PCF plant with scrubbers. While this is not a significant difference (well within the uncertainties of the cost analysis), it should be noted that a $5,000,000 contingency differential was incurred by the AFBC plant to reflect is less mature technology, and no credit was taken for the potential sale of spent bed material. In addition, no credit was taken for the potential of the calcium in the ash of the western coal to reduce limestone requirements. It should be noted that preliminary analysis indicates that as the sulfur content in the coal increases, the apparant 4% advantage of the AFBC plant disappears. Further, as stricter SO_2 emission standards are considered, the AFBC advantage again disappears when compared to a PCF plant with scrubbers. The two most significant factors which can reduce the generating cost of AFBC plants compared to PCF plants with scrubbers are: reduction of the Ca—S ratio required to meet SO_2 emission limits; and utilization of spent bed material, which might turn a debit into a credit. The potential of the calcium in the ash of the western coal to reduce limestone requirements presents the possibility of a major improvement in AFBC efficiency and cost. Continued R and D efforts on the utilization of western coal and western lignite in fluidized-bed may well produce

41468 (M—78-68(Vol.2), pp 388-399) **Design of a gas turbine plant with a pressurized fluidized bed combustor.** Schilling, H.D.; Schreckenberg, H.; Weid, E. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

The flowsheet of the AGW pilot plant is depicted in a drawing. The compressor takes in the air from the ambient and develops a pressure ratio of 4.5. The compressed air is then led to the combustor and divided into two streams. One serves to fluidize the bed as combustion air, the other one is passed through the immersed heat exchanger. The combustion gas, having a temperature of some 860°C, is dedusted in an electrostatic precipitator and joins the hot air prior to entering the turbine. After expansion the heat of the exhaust gas is utilized in a waste heat boiler. As the PFB combustor is to be operated at constant temperature, part load operation is achieved by mixing the hot gas with compressor air via a bypass line and thus lowering the turbine inlet temperature, while maintaining mass flow. The use of an electrostatic precipitator for hot gas clean-up is an alternative to systems, employing cyclones or granular filters respectively. The availability of an existing compressed air grid enables the independent operation of the combustor and the omission of a start-up motor and thus leads to a greater flexibility of the pilot plant.

41469 (M—78-68(Vol.2), pp 626-640) **Particulate control for pressurized fluidized-bed combustion processes.** Ciliberti, D.F.; Keairns, D.L.; Archer, D.H. (Westinghouse R and D Center, Pittsburgh, PA). Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Particulate control for pressurized (PFBC) fluidized-bed combustion processes is important in order to meet environmental and process constraints. Control requirements and particulate properties, loadings, and size distribution projections from fluidized-bed combustion processes have been developed. Particulate control options are identified for pressurized fluidized-bed combustion processes. A high-temperature, high-pressure particulate control test facility has been constructed to test control equipment for PFBC systems. The facility is designed to operate at flows up to 30 m^3/min at 1034 kPa and 875°C.

41470 (M—78-68(Vol.2), pp 642-653) **Particle size in pressurized combustors.** Pillai, K.K. Dec 1978.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

For the design of fluidized combustion equipment and for consideration of the effects of changing operating conditions, it is desirable to have a simple method of relating the effects of the variables on fluidization. The size grading of the particles comprising the fluidized bed must be such that (i) segregation of the larger particles at the bottom of the bed and consequent de-fluidization is avoided and (ii) elutriation of the smaller particles must not be excessive. Conditions for minimum fluidization can be correlated by an empirical relationship between Archimedes number and Reynolds number, and conditions for the terminal velocity of single particles are normally related by a plot of drag coefficient against Reynolds number. Both these correlations are inconvenient for visualizing the effects of changes in fluidizing velocity or particle size because the expressions for C/sub D/ and Re both include velocity and particle size. A more convenient way of expressing the relationships for both minimum fluidization and free fall of single particles is in the form of relationships between a parameter which is termed Fluidazation number, F/sub n/ = Ar/sup 1/3/ = (3C/sub D/Re^2/4) /sup 1/3/ and a parameter termed Velocity number V/sub n/ = (4Re/3C/sub D/)/sup 1/3. F/sub n/ is proportional to the particle diameter and independent of velocity; V/sub n/ isproportional to velocity and independent of the particle size. The terminal velocity of single particles is of importance because particles of a diameter smaller than those having a terminal velocity equal to the fluidizing velocity are rapidly elutriated from a fluidized bed.

41471 (ORO—5552-4(Vol.1)) **Improving the efficiency, safety, and utility of woodburning units. Quarterly report No. WB-4, June 15—September 15, 1978. Volume 1.** Dyer, D.F.; Maxwell, T.T.; Maples, G. (Auburn Univ., AL (USA). Dept. of Mechanical Engineering). 15 Sep 1978. Contract EC-77-S-05-5552. 201p. Dep. NTIS, PC A10/MF A01.

The first year of work on improving the safety and performance of wood-burning heating equipment is reported. Testing procedures have been developed for rating woodburning units, data have been taken on several currently produced units, analytical studies of the process occurring within a woodburning unit are underway, a study of wood pyrolysis has been undertaken and a preliminary study of creosote formation has been completed. Technical information has been transmitted to the woodburning industry.

41472 **Boiler having a hot gas generator for burning liquid or gaseous fuels.** Vogt, A.; Kunkel, W. (to Interliz Anstalt). US Patent 4,147,134. 3 Apr 1979. Priority date 5 Nov 1976, German, Federal Republic of (F.R. Germany), 8p.

The hot gas generator comprises a combustion chamber unit, into the combustion chamber of which the fuel and air for combustion are introduced and in which the combustion of the fuel takes place. The combustion gases are conveyed out of the combustion chamber into a water cooled boiler firebox. A compressor supplies the air for combustion into the combustion chamber unit. A flue gas conduit, which leads to the flue gas vent of the boiler, at its inlet end, which is connected with the boiler firebox, is connected with the air intake of the compressor of the hot gas generator ro recirculating a regulatable amount of flue gases into the combustion chamber unit of the hot gas generator. The flue gas conduit offers a resistance to the flow of flue gas therein, which resistance is greater than the chimney draft force present in the flue gas vent of the boiler.

41473 **Method and apparatus for decreasing nitrogen oxides and unburnt hydrocarbons when burning hydrocarbon fuels.** Egnell, R.A.; Moritz, M.I. (to Kommanditbolaget United Stirling (Sweden) AB & Co.). US Patent 4,145,178. 20 Mar 1979. Priority date 24 Jun 1976, United Kingdom of Great Britain and Northern Ireland (UK), 6p.

Fuel is burned in two chambers, the first with excessive air to produce combustion gases containing oxygen and the second using cooled combustion gases from the first to constitute the oxidizing medium. Preferably the proportions of fuel in the two chambers are equal and the combustion gases are cooled to about 800°C.

MARINE ENGINEERING

REFER ALSO TO CITATION(S) 40296, 40297, 40308, 40316

41474 **Environmental impact of North Sea oil platforms.** Dicks, B.M. pp 1-21 of Marine environment and oil facilities. London, England; Institution of Civil Engineers (1979).

From Marine environment and oil facilities; London, UK (20 Sep 1978).

Environmental implications of the presence of offshore platforms in the North Sea are outlined and their environmental impact discussed. However, at present the limited data available regarding the impact of oil platforms on the environment leaves no room for complacency and makes it necessary to undertake environmental monitoring in order to ensure that environmental effects are within acceptable limits. A monitoring system is outlined and discussed.

POLLUTION CONTROL EQUIPMENT

REFER ALSO TO CITATION(S) 41588

41475 (CONF-780819—P2, pp 1005-1014) **CSL engineering design handbook.** Shacter, A. (Chemical Systems, Lab., Aberdeen Proving Ground, MD). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

An engineering design handbook recently published describes a high efficiency air cleaning filtration system. This system, modified from the basic nuclear concept, was designed to meet the criteria for a chemical demilitarization facility. Topics covered in the book

include both basic and detailed filtration and ventilation design considerations.

41476 (CONF-780819—P2, pp 1018-1043) **Loading capacity of various filters for sodium oxide/hydroxide aerosols.** McCormack, J.D.; Hilliard, R.K.; Barreca, J.R. (Westinghouse Hanford Co., Richland, WA). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

The loading capacity of commercially available prefilters and HEPA filters is reported for sodium oxide and sodium hydroxide fumes in moist and normal air. The test aerosol is characterized and is considered to be typical of that which would exist during accidents involving sodium fires in breeder reactors, plants, and laboratory facilities. Sodium pool fires of 0.6 m^2 area in a closed 330 m^3 room serve as an aerosol source to supply the recirculating filter test loop. The room and filter inlet stream is sampled to determine airborne particle size, mass concentrations, and dew point. Inlet mass concentrations of the test aerosol ranged up to 16 g/m^3. The chemical forms were mixtures of Na_2O_2, NaOH, Na_2CO_3, and their hydrates. Seven types of HEPA filters and seven types of prefilters were examined in six test series. The holding capacity of the filters ranged from 0.6 to 3.9 kg at 5 kPa pressure drop for aerosols generated in moist and normal air. The early time and moist aerosols showed the lowest loading capacities. Up to 5.1 kg of sodium carbonate aerosols were held. Flow and media efficiency had only a minor effect on the loadings achieved. No combination of prefilters tested was effective in providing increased holding capacity for the associated HEPA filter.

41477 **Scrubber for contaminated gas.** Winters, H. (to Buettner-Schilde-Haas AG). US Patent 4,148,616. 10 Apr 1979. Priority date 8 Apr 1974, German, Federal Republic of (F.R. Germany), 8p.

The scrubber has a substantially rotationally symmetrical vortex chamber provided at one end with an axial gas outlet whose diameter is substantially smaller than the diameter of the chamber. A coaxial impeller wheel is located at the other axial end of the chamber and admits into the region of the chamber periphery a stream of contaminated gas which has a component of movement in circumferential direction of the chamber. A plurality of spray nozzles spray a washing liquid into the chamber for contact with the contaminated gas therein.

41478 **Apparatus for cleaning stack gas and using same for generation of electric power.** Hegemann, K.R. US Patent 4,145,193. 20 Mar 1979. Priority date 6 Nov 1973, German, Federal Republic of (F.R. Germany), 6p.

Stack gas is first passed through a coarse-particle separator and then a prescrubbing tower. Then this gas, which is under pressure, is passed through a pair of differential-pressure (annular-gap) washers. The output side of one of the washers is connected directly to a droplet separator at the output of the system. The outlet of the other washer is connected through a turbine driving an electric generator and having its output side in turn connected to the droplet separator. The control body of at least the washer which is connected directly to the droplet separator is adjustable so as to maintain a constant backpressure in the system at the blast furnace from which the stack gas comes. The washer connected to the turbine is set up to pass at least four times as much of the gas as the other washers so that most of the gas passes through the turbine, undergoing a pressure drop that is transformed into the work of driving the turbine and generates electricity.

41479 **Process for the removal of nitrogen oxide.** Nagaoka, T.; Nishimura, T.; Ono, S.; Nagata, S.; Yamashita, N.; Tanaka, Y.; Hatabu, Y. (to Ube Industries, Ltd.). US Patent 4,145,399. 20 Mar 1979. Priority date 31 Jan 1977, Japan, 12p.

A process for removing nitrogen oxides (NO/sub x/) from a waste gas containing 300 through 20,000 ppM of NO/sub x/ is disclosed. In the process, the waste gas containing NO/sub x/ is adjusted to a molar ratio of NO/NO_2 of approximately 1 and is then scrubbed with a scrubbing solution containing an alkali metal hydroxide in a first column. The scrubbing solution is removed from the first column before the alkali metal hydroxide is completely consumed. The removed scrubbing solution is then contacted in a second column with a gas having 1.0 through 60.0% by volume NO/sub x/ which has been adjusted to a molar ratio of NO/NO_2 of approximately 1. Thus, the NO/sub x/ content of the purified gas can be lowered to far less than 200 ppM and post-treatment problems of the scrubbed solution can be effectively solved.

41480 **Method of removing nitric oxide from gases.** Sermon, P.A. (to Johnson, Matthey and Co., Ltd.). US Patent 4,143,120. 6 Mar 1979. Priority date 4 Mar 1974, United Kingdom of Great Britain and Northern Ireland (UK), 6p.

The invention relates to a process for the purification of air and other gaseous media. The invention is particularly directed towards a process for the decomposition of one or more of the oxides of nitrogen present in a gas stream containing gaseous compositions such as carbon monoxide and hydrocarbon. In more detail the process of the invention includes the step of contacting the air or other gaseous media with a catalyst comprising a bronze selected from the group consisting of: (a) compositions having the general formula A/sub x/BO/sub y/ where A is selected from the group consisting of the alkali metals, the alkaline earth metals, the rare earths, Ba, PB, Tl, Ni, Cu, NH_4, Ag, and H; B is selected from the group consisting of Ti, V, Nb, Mo, Ta, W, Pt, and Re, with x normally in the range $0 < 2 <$ and y normally lies between 2 and 3; and (b) compositions having the general formula C/sub x/D_3O_4 where C is selected from the group consisting of Na, Mg, Ni, Ca, Cd, and Sr; D is Pd or Pt and x normally has values of $0 < x < 1$.

POWER CYCLES

BRAYTON

REFER ALSO TO CITATION(S) 40484

OTHER

41481 **Energy conversion devices.** Reytblatt, Z. US Patent 4,148,292. 10 Apr 1979. Filed date 21 Oct 1976. 14p.

The invention relates to energy conversion devices for converting between fluid flow energy and rotational mechanical energy, utilizing Coriolis forces which are produced when there is a relative motion velocity non-parallel to an instant rotation axis direction. In one embodiment, two piston members move around in an annular chamber of a housing member journalled on a support member for rotation relative thereto about a first axis extending in a diametral plane of the annular chamber, the support member being journalled for rotation about a second axis intersecting and transverse to the first axis, the second axis being a stationary axis forming the principal axis of rotation. With pressurized fluid applied to move the pistons around, the device operates as an engine. In a second embodiment, means are provided for effecting combustion of an air-fuel mixture within the annular chamber, to provide an internal combustion engine. A third embodiment is similar to the second embodiment except that three pistons are provided in a manner to provide intake and compression operations within the annular chamber. In a fourth embodiment, pistons oscillate within cylindrical chambers of a housing member which is supported on a support member for rotation about an axis angularly related to the axes of the cylindrical chambers, the support member being supported for rotation about a second axis intersecting and transverse to the first axis, and with means being provided for effecting combustion within the chambers to oscillate the pistons.

PARTICLE ACCELERATORS

REFER ALSO TO CITATION(S) 41275

41482 **Technique for profiling ^1H with 2.5-MeV Van de Graaff accelerators.** Doyle, B.L.; Peercy, P.S. (Sandia Laboratories, Albuquerque, New Mexico 87185). *Appl. Phys. Lett.;* **34**: No. 11, 811-813(1 Jun 1979).

We describe an elastic recoil detection (ERD) analysis technique for profiling ^1H in the near-surface regions of solids using a 2.5-MeV Van de Graaff accelerator commonly used for ion-backscattering analysis. Energy analysis of ^1H forward scattered by 2.4-MeV ^4He incident on the target tilted at an angle of $\sim 75^0$ yields a depth resolution of $<$ or ≈ 700 A and a sensitivity of better than 0.1 at.% for ^1H to depths of $<$ or ≈ 0.6 μm in solids.

DESIGN, DEVELOPMENT, AND OPERATION

REFER ALSO TO CITATION(S) 41510, 41920, 42113, 42114

41483 (BNL—50947, pp 59-83) **Anti KN system.** Tripp, R. (Lawrence Berkeley Lab., CA). 1978.

From Workshop on the AGS fixed target research program; Upton, NY, USA (8 Nov 1978).

The experimental status of Y*'s as revealed mostly by K^-p formation experiments is discussed to show what progress has been made in the field (nearly all stemming from experiments done at the AGS), and to point out some deficiencies in understanding which could be remedied by further experiments.

41484 (LBL—8871) **Accelerator and Fusion Research Division. Annual report, October 1977—September 1978.** (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1979. Contract W-7405-ENG-48. 89p. Dep. NTIS, PC A05/MF A01.

Research is reported for the combined groups consisting of the Accelerator Division and the Magnetic Fusion Energy Group. Major topics reported include accelerator operations, magnetic fusion energy, and advanced accelerator development. (GHT)

41485 (LBL—8871, pp 1-11) **Accelerator operations.** Apr 1979. In Accelerator and Fusion Research Division. Annual report, October 1977—September 1978.

Operations of the SuperHILAC, the Bevatron/Bevalac, and the 184-inch Synchrocyclotron during the period from October 1977 to September 1978 are discussed. These include ion source development, accelerator facilities, the Heavy Ion Spectrometer System, and Bevelac biomedical operations. (GHT)

41486 (LBL—8871, pp 41-73) **Advanced accelerator development.** Apr 1979. In Accelerator and Fusion Research Division. Annual report, October 1977—September 1978.

Construction and alignment of the PEP storage ring, and fabrication and construction of the ESCAR accelerator are covered. Heavy ion fusion is discussed briefly. (GHT)

BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS

REFER ALSO TO CITATION(S) 41504, 41546, 41549

41487 (CONF-790327—99) **Noninteractive beam position and size monitor for heavy ions.** Bogaty, J.M. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 4p. Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

The Ion Beam Fusion development program at Argonne National Laboratory requires noninteractive size measurements of a pulsed, 30 mA, Xe^{+1} particle beam. Pulses of 100 μs duration will be produced by the 1.5 MV preaccelerator; therefore, fast response diagnostics are required. Techniques of utilizing residual gas ionization to profile particle beams have been reported before. This paper discusses the development of vertical and horizontal beam profile monitors that are synchronously clocked to interface with oscilloscopes and computers. Modern integrated circuitry is utilized which boosts performance to a point where pulses as short as 20 μs can be analyzed. A small, simple ionization chamber is shown which provides sixteen channels of position resolution over 12 cm of aperture.

41488 (CONF-790327—102) **1 to 12 GeV/c beam transport for transverse or longitudinally polarized protons.** Colton, E.P. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 5p. Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

A two-stage beam transport for polarized protons has been constructed and operated at the Argonne ZGS. The first stage delivers vertically polarized protons (N-type) to an elastic scattering polarimeter consisting of a 10 cm long LH_3 target and two moveable sets of forward and recoil scintillation counters. The unscattered protons transported through the beam's second stage are focused onto the polarized proton target PPT-III; this target utilizes a 2.5 T R and A magnet to produce target polarizations in the horizontal plane, either in the beam direction (L-type) or transverse to it (S-type). The second stage of the beam is equipped with a combination of superconducting solenoids and dipole magnets; thus the beam polarization can also be rotated to point in the L or S direction. The entire system has been operated successfully over the momentum range 1.0 to 11.75 GeV/c with NS, LS, SS, and LL beam target spin directions.

41489 (LA-tr—79-4) **Linear ion accelerator with high-frequency strong focusing. Dynamics of the beam in sections with spatially homogeneous focusing: Part 2 .** Kapchinskii, I.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1979. Translation of INZH-72-2. July 1972. 25p. Dep. NTIS, PC A02/MF A01.

In the first part of this work, the longitudinal and transverse oscillations of ions in sections of a linear accelerator with spatially homogeneous strong focusing were examined. On the basis of the deduced analysis, the optimal parameters of such sections are provided, both for the case of an accelerator with quasi-stationary standing waves and for an accelerator with a constant synchronous phase. The electrical and mechanical sectional error tolerance are also considered.

41490 (LBL—8809) **Possible lower limit to linac emittance.** Staples, J.W.; Jameson, R.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1979. Contract W-7405-ENG-48. 5p. (CONF-790327—89). Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

Numerical calculations made by several groups have always shown that an asymptotic lower exit emittance exists for linacs operating with high beam current as the input emittance is reduced to zero. In this paper, a mechanism for this limit is shown to be spread in the betatron frequencies of the individual particles due to the combination of space charge and rf gap forces, causing different transverse trajectories correlated with the instaneous longitudinal position of the particle. These trajectories cannot all be simultaneously matched to the average restoring forces, resulting in an overall emittance increase if the the space charge force is a large fraction of the restoring force. In principle, equilibrium distributions may exist which would not grow. Raising the linac frequency or reducing longitudinal emittance improves the situation, but higher injection energy does not.

41491 (LBL—8951) **High purity radioactive beams at the bevalac.** Alonso, J.R.; Chatterjee, A.; Tobias, C.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1979. Contract W-7405-ENG-48. 5p. (CONF-790327—93). Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

Peripheral nuclear fragmentation reactions of primary Bevalac heavy ion beams are used to produce secondary beams of radioactive nuclei. The large cross section and small deflection of the projectile fragments lead to high production and delivery efficiency for these beams. Dispersive beam transport allows good separation and purification of the desired secondary beams. ^{11}C and ^{19}Ne beams of high purity and good intensity (almost 0.2% of the primary beam current) are presently being used for biomedical experiments.

41492 (ORNL/TM—5419/V2) **Calculations pertaining to the design of a prebuncher for a 150-MeV electron linear accelerator. II. Radial motion.** Alsmiller, R.G. Jr.; Alsmiller, F.S.; Barish, J. (Oak Ridge National Lab., TN (USA)). May 1979. Contract W-7405-ENG-26. 36p. Dep. NTIS, PC A03/MF A01.

In the previous paper, calculated results based on a one-dimensional ballistic model were presented to indicate the extent to which a current pulse of 150-keV electrons containing 1 μC of charge and having a duration of 15 nsec (FWHM) could be bunched by a combination of accelerating and decelerating voltage gaps followed by a drift space. A very approximate perturbation model is used here to determine the extent to which the prebuncher performance determined previously is modified by radial electron motion. It is found that if a longitudinal magnetic field of 1 kG is applied in the region containing the voltage gaps and if a sufficiently strong longitudinal magnetic field (~ 3 kG) is applied in the drift space the prebuncher performance determined here is essentially the same as that shown in the previous paper.

41493 (SLAC-PUB—2295) **Computer calculations of traveling-wave periodic structure properties.** Loew, G.A.; Miller, R.H.; Early, R.A.; Bane, K.L. (Stanford Univ., CA (USA)). Mar 1979. Contract EY-76-C-03-0515. 4p. (CONF-790327—123). Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

The versatility and accuracy of programs such as LALA and specially SUPERFISH to calculate the rf properties of standing-wave cavities for linacs and storage rings is by now well established. Such rf properties include the resonant frequency, the phase shift per periodic length, the E- and H-field configurations, the shunt impedance per unit length and Q. While other programs such as TWAP have existed for some time for traveling-wave structures, the wide availability of SUPERFISH makes it desirable to extend the use of this program to traveling-wave structures as well. That is the purpose of this paper. In the process of showing how the conversion from standing waves to traveling waves can be accomplished and how the group velocity can be calculated, the paper also attempts to clear up some of the common ambiguities between the properties of these two types of waves. Good agreement is found between calculated results and experimental values obtained earlier.

41494 (LA-tr—79-8) **Ion linear accelerator with strong high-frequency focusing. Beam dynamics in the section with spatially uniform focusing: Part 1.** Kapchinskii, I.M. (Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (Germany, F.R.)). 1979. Translation of IHP-INZH—72-29. 32p. Dep. NTIS, PC A03/MF A01.

Previous investigations which were carried out in the Institute for High Energy Physics have shown that a further improve-

ment of the parameters of an ion-linear accelerator is possible with departure from the widespread Alvarez—Blewett systems. In this connection, a design for a linear accelerator system is proposed whereby acceleration and focusing result with the help of an electric high-frequency field which possesses no axial symmetry.

41495 Alternating phase focused linacs. Swenson, D.A. (to Dept. of Energy). US Patent Application 912,785. 5 Jun 1978. 15p.

A heavy particle linear accelerator employing rf fields for transverse and longitudinal focusing as well as acceleration. Drift tube length and gap positions in a standing wave drift tube loaded structure are arranged so that particles are subject to acceleration and succession of focusing and defocusing forces which contain the beam without additional magnetic or electric focusing fields.

41496 Electron cooling and new possibilities in elementary particle physics. Budker, G.I.; Skrinskii, A.N. (Nuclear Physics Institute, Siberian Division, USSR Academy of Sciences, Novosibirsk). *Sov. Phys. - Usp. (Engl. Transl.);* **21**: No. 4, 277-296(Apr 1978).

This review is devoted to a new method in experimental physics: electron cooling, which opens the possibility of storing intense and highly monochromatic beams of heavy particles and carrying out a wide range of experiments with high luminosity and resolution. The method is based on the cooling of beams by an accompanying electron flux as the result of Coulomb collisions of the particles. In the first part of the review the theoretical basis of the method is briefly considered. The apparatus NAP-M is described with its electron cooling, and the results of successful experiments on cooling a proton beam are presented. In the second part the new possibilities opened by the use of electron cooling are discussed: storage of intense beams of antiprotons and achievement of proton-antiproton colliding beams, performance of experiments at the ultimate in low energies (with participation of antiparticles), storage of polarized antiprotons and other particles, production of antiatoms, storage of antideuterons, and experiments with ion beams.

AUXILIARIES AND COMPONENTS

41497 (LBL—8908) **Impact of storage rings on elementary particle physics.** Trilling, G.H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1979. Contract W-7405-ENG-48. 8p. (CONF-790327—90). Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

It is well known that new experimental discoveries often closely follow the development of new technology. There is hardly a better example of this than the close coupling between new discoveries in the frontiers of elementary particle physics and the development of the art and science of making high-energy accelerators. It is almost twenty-five years since the construction of the Bevatron made possible the discovery of the antiproton; and, since that time, knowledge and understanding of particle physics has made enormous strides in step with new developments in both the accelerator and the detector arts. An attempt is made to document how intimately many of the recent advances have been tied to the success in the development of storage rings and colliding beams.

ION SOURCES

41498 (BNL—50947, pp 330-343) **Polarized protons in the AGS: hardware and costs.** Ratner, L. (Argonne National Lab., IL). 1978.

From Workshop on the AGS fixed target research program; Upton, NY, USA (8 Nov 1978).

The hardware systems that are necessary to obtain an accelerated beam of polarized protons at the AGS are described, and some of the things that have been done at the ZGS to achieve a polarized beam there are pointed out.

41499 (CONF-790327—129) **High energy polarized deuterons at the Argonne National Laboratory zero gradient synchrotron.** Parker, E.F.; Brandeberry, F.E.; Crosbie, E.A.; Knott, M.J.; Potts, C.W.; Ratner, L.C.; Schultz, P.F.; Suddeth, D.E. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 5p. Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

Modifications made on the ZGS to allow the acceleration of polarized deuterons and the operational experiences with the first production run with this beam are described.

41500 (LBL—8359) **Large aperture contact ionized Cs^{+1} ion source for an induction linac.** Abbott, S.; Chupp, W.; Faltens, A.; Herrmannsfeldt, W.; Hoyer, E.; Keefe, D.; Kim, C.H.; Rosenblum, S.; Shiloh, J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; Stanford Linear Accelerator Center, CA (USA)). Mar 1979. Contract W-7405-ENG-48. 4p. (CONF-790327—116).

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

A 500 KeV one-ampere Cs^{+1} ion beam has been generated by contact ionization with a 30 cm dia. iridium hot plate. Reproducibility of space charge limited ion current wave forms at repetition rates up to 1 Hz has been verified. The beam is characterized to be very bright and suitable as an ion source for the induction linac based heavy ion fusion scheme. The hot anode plate was found to be reliable and self-cleaning during the operation.

41501 (ORO—1667-17, pp 86-90) **Improved source of metastable beam.** Clegg, T.B. (Univ. of North Carolina, Chapel Hill); Mitchell, S.M.; Manning, H.L.; Murphy, K. 1978.

In Triangle Universities Nuclear Laboratory annual report: TUNL XVII, 1 January—31 December 1978.

Improvements in polarized beam intensity through extensive work on duoplasmatron and lens geometries are reported. 2 figures. (RWR)

41502 (ORO—1667-17, pp 90-91) **Improved control links between the polarized ion source and the computer.** Clegg, T.B. (Univ. of North Carolina, Chapel Hill); Seward, W.; Wright, M.; Roberson, N.R.; Edwards, S.E.; Knott, A.; Willis, J.; Juelich, R.E. 1978.

In Triangle Universities Nuclear Laboratory annual report: TUNL XVII, 1 January—31 December 1978.

A logic diagram of the components of the polarized source microprocessor system is given. 1 figure. (RWR)

41503 (SLAC-PUB—2261) **One nanosecond pulsed electron gun systems.** Koontz, R.F. (Stanford Linear Accelerator Center, CA (USA)). Feb 1979. Contract EY-76-C-03-0515. 2p. (CONF-790327—122). Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

At SLAC there has been a continuous need for the injection of very short bunches of electrons into the accelerator. Several time-of-flight experiments have used bursts of short pulses during a normal 1.6 micro-second rf acceleration period. Single bunch beam loading experiments made use of a short pulse injection system which included high power transverse beam chopping equipment. Until the equipment described in this paper came on line, the basic grid-controlled gun pulse was limited to a rise time of 7 nanoseconds and a pulse width of 10 nanoseconds. The system described here has a grid-controlled rise time of less than 500 pico-seconds, and a minimum pulse width of less than 1 nanosecond. Pulse burst repetition rate has been demonstrated above 20 MHz during a 1.6 microsecond rf accelerating period. The order-of-magnitude increase in gun grid switching speed comes from a new gun design which minimizes lead inductance and stray capacitance, and also increases gun grid transconductance. These gun improvements coupled with a newly designed fast pulser mounted directly within the gun envelope make possible subnanosecond pulsing of the gun.

INJECTION AND EXTRACTION SYSTEMS

41504 (LBL—8409) **Computational studies of beam dynamics in the ETA gun.** Paul, A.C.; Neil, V.K. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1979. Contract W-7405-ENG-48. 5p. (CONF-790327—88). Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

A new general purpose computer code call EBQ, has been written to simulate the beam dynamics of the ETA, find its beam emittance and evaluate effects of changes in the electrode positions and external magnetic fields. The original calculations of the ETA were made with EGUN and yielded considerable insight into the operation of the device in the non-relativistic regime. The EBQ code was written specifically to attend to the special problems associated with high current relativistic beam propagation in axially symmetric machines possessing external 2-dimensional electric and magnetic fields. The coherent electric and magnetic self-fields of the beam must be calculated accurately. Special care has been used in the relativistic regime where a high degree of cancellation occurs between the self-magnetic and self electric forces of the beam. Additionally, EBQ can handle equally well non-relativistic problems involving multiple ion species where the space charge from each must be included in its mutual effect on the others. Such problems arise in the design of ion sources where different charge and mass states are present.

EXPERIMENTAL FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 41486, 41492, 41547

41505 (BNL—50947) **Workshop on the AGS fixed-target research program.** Ahrens, L.; Schewe, P.; Wanderer, P.; Weisberg, H. (eds.). (Brookhaven National Lab., Upton, NY (USA)). 1978. Contract EY-76-C-02-0016. 384p. (CONF-781184—). Dep. NTIS, PC A17/MF A01.

From Workshop on the AGS fixed target research program; Upton, NY, USA (8 Nov 1978).

The summarized results of a two day workshop to determine experiment programs for the Brookhaven AGS during the construction period of the ISABELLE storage rings and after are presented. Topics covered include: experiments with low-energy beams; experiments with higher energy beams; neutrino physics; and polarized protons. (GHT)

41506 (BNL—50947, pp 2-10) **AGS capabilities and possible improvements.** Weng, W.T. (Brookhaven National Lab., Upton, NY). 1978.

From Workshop on the AGS fixed target research program; Upton, NY, USA (8 Nov 1978).

This brief review is to give a summary of both the current AGS capabilities and several possible improvements which either have been underway for awhile or are still at the stage of contemplation.

41507 (BNL—50947, pp 11-20) **Funding outlook and the impact of ISABELLE.** Wallenmeyer, W.A. (Department of Energy, Washington, DC). 1978.

From Workshop on the AGS fixed target research program; Upton, NY, USA (8 Nov 1978).

Funding levels for high energy physics are shown for the period 1965—1979 broken down by funding sources. Trends in the allocation of funds are discussed and implications for the Brookhaven AGS are considered. (GHT)

41508 (BNL—50947, pp 21-27) **CERN PS program and low energy anti p proposal.** Perreau, J.M. (European Organization for Nuclear Research, Geneva, Switzerland). 1978.

From Workshop on the AGS fixed target research program; Upton, NY, USA (8 Nov 1978).

General status of the CERN PS synchrotron is covered and physics research programs are discussed. These include: ICE, the initial cooling experiment; the anti p factory; and the low energy antiproton ring. (GHT)

41509 (BNL—50947, pp 28-47) **Present status of KEK.** Sato, T. (National Lab. for High Energy Physics, Ibaraki-Ken, Japan). 1978.

From Workshop on the AGS fixed target research program; Upton, NY, USA (8 Nov 1978).

Operation of the 12 GeV proton synchrotron at the KEK national laboratory for high energy physics in Japan is described, along with the experimental facilities and the physics program. (GHT)

41510 (BNL—50947, pp 48-58) **Physics program at LAMPF.** Hoffman, C.M. (Los Alamos Scientific Lab., NM). 1978.

From Workshop on the AGS fixed target research program; Upton, NY, USA (8 Nov 1978).

Some highlights of the physics program being carried out at LAMPF are described. The particle physics experiments are emphasized. LAMPF is truly a multidisciplinary facility with all sorts of physics, chemistry and biology experiments being carried out.

41511 (BNL—50947, pp 84-113) **Kaons and antiprotons as probes of the nucleus.** Dover, C.B. (Univ. of Pennsylvania, Philadelphia). 1978.

From Workshop on the AGS fixed target research program; Upton, NY, USA (8 Nov 1978).

The K^+ is the only hadron which is weakly absorbed in nuclei over a sizeable energy range (p/sub lab/ $\leq$ 0.8 GeV/c), with a mean free path of 5 to 7 fm in nuclear matter. In this sense, it can be viewed as the electron of strong interaction physics. The theoretical description of the mechanism of K^+ induced reactions on nuclei is in many cases simple and controllable. This allows the extraction of nuclear structure information with a minimum of ambiguity, unlike the situation for strongly absorbed probes such as the pion. The following possibilities can be emphasized for K^+ studies on nuclei: (a) extraction of neutron densities from measurements of elastic and total cross sections; (b) inelastic scattering of K^+ to particular residual nuclear states. The selection rules are discussed and the K^+ is compared to e^-, $\pi+-$, p and anti p as nuclear probes. The excitation of high spin, unnatural parity states is particularly interesting, both from the nuclear structure point of view and as a means of discriminating between various models for the elementary K^+- nucleon amplitudes. The K^+ could also effectively be used to explore the systematics of giant monopole and quadrupole resonances in nuclei, as well as the isospin splitting of giant resonances through kaon charge exchange reactions; and (c) quasiparticle properties of more deeply bound nucleon orbitals in the shell model via the (K^+, K^+ p) reaction; also K^+ scattering with large energy loss (deep inelastic processes).

41512 (BNL—50947, pp 128-139) **Stopping pion and muon beams at the Brookhaven AGS.** Kossler, W.J. (College of William and Mary, Williamsburg, VA). 1978.

From Workshop on the AGS fixed target research program; Upton, NY, USA (8 Nov 1978).

Beyond the primary physics justification for stopping a π and μ beam described by A. Sachs at this meeting, there are several factors which encourage setting up such a beam at the AGS: (1) Much of the equipment, including bending and focusing magnets, the SREL meson channel itself, power supplies and shielding, is currently available from SREL and Nevis. Other laboratories, however, have expressed interest in this equipment. (2) The π/μ fluxes at the AGS would be over 100 times those that were available at SREL and over 10 times those at Nevis. (3) Although the projected fluxes would not be as high as at LAMPF, they are roughly within an order of magnitude and would have the advantage of a 40% duty factor as compared with 6% at LAMPF.

41513 (BNL—50947, pp 140-143) **Experiments with low energy muons and pions.** Sachs, A.M. (Columbia Univ., Irvington-on-Hudson, NY). 1978.

From Workshop on the AGS fixed target research program; Upton, NY, USA (8 Nov 1978).

The arbitrarily defined field of Intermediate Energy Physics covers a broad spectrum of experiments ranging from the use of muons as solid state probes through the atomic physics of muonium, problems of nuclear structure, and the weak and electromagnetic interactions of elementary particles. The use of the AGS beams for experiments such as accurate nuclear spectroscopy, for which LAMPF has very versatile facilities is not foreseen. Specific examples, particularly those involving weak and electromagnetic interactions are given for areas where the proposed beams could be used.

41514 (BNL—50947, pp 144-146) **Some opportunities for weak interaction investigations at the AGS.** Adair, R.K. (Yale Univ., New Haven, CT). 1978.

From Workshop on the AGS fixed target research program; Upton, NY, USA (8 Nov 1978).

Investigations of the weak interaction decays of the various elementary particles are still necessary if many of the most important characteristics of the weak interactions are to be understood. For some of the more important varieties of measurements which seem to be required, there appear to be considerable advantages to working with the decays of particles which are nearly at rest in the laboratory system or, at least, moving with mode-rate velocities. The natural kinematic region covered by the production of these particles at the AGS is, then, nearly optimum for large varieties of important measurements. Such extremely important problems as the determination of the character of CP invariance violation, the possible coupling of second class hadron currents to the weak interaction and the possible coupling of right-handed quark currents to the weak interactions might, possibly, be attacked best by experiments designed to use beams which are produced most conveniently by accelerators such as the AGS. Two experiments concerning the weak interactions of unstable particles produced at the AGS are discussed.

41515 (BNL—50947, pp 148-180) **Review of neutrino physics at Brookhaven.** Murtagh, M.J. (Brookhaven National Lab., Upton, NY). 1978.

From Workshop on the AGS fixed target research program; Upton, NY, USA (8 Nov 1978).

The high event rate and relative simplicity of the produced final states are the unique features of neutrino physics at Brookhaven which make it particularly suitable for the study of many topics of current interest. This not only applies to exclusive charged current studies, which are the province of the 7' bubble chamber program but to the elastic scattering from protons and electrons which is the focus of the recently approved experiment. Also, interesting results on multipion neutral current production and charm baryon production can be expected from the 7' chamber in the not too distant future.

41516 (BNL—50947, pp 181-211) **Neutrino physics at the AGS.** Sokolsky, P. (Columbia Univ., New York, NY). 1978.

From Workshop on the AGS fixed target research program; Upton, NY, USA (8 Nov 1978).

The AGS neutrino beam is the last low energy (1 to 2 GeV) neutrino beam left. As more work is done at higher energies and as the whole realm of new physics (whose threshold seems barely attainable at AGS ν energies) is explored in increasing detail, it is appropriate to ask what physics remains to be done here. To answer this question, current theory and experiment are confronted, not in an attempt to confirm or refute theoretical (or experimental) prejudices, but to ask if present experiments at low energies are good enough. In the process, the recent AGS neutrino experimental program are reviewed.

41517 (BNL—50947, pp 212-232) **Beam dump experiments at the AGS.** Soukas, A. (Brookhaven National Lab., Upton, NY); Wanderer, P.; Weng, W. 1978.

From Workshop on the AGS fixed target research program; Upton, NY, USA (8 Nov 1978).

Searches for the prompt production of weak or semi-strongly interacting particles in a neutrino beam dump and their subsequent interaction or decay have been performed at the AGS. The experiment using the totally active liquid scintillator detector is described and the results of the spark chamber detector are mentioned. An exposure of a copper beam dump to two orders of magnitude more protons than in previous searches at 28 GeV has yielded 104 neutrino-like events in the detector. The events from the beam dump are compared directly with those from π and K decay neutrinos produced concurrently in the normal long neutrino decay path following a 15 cm brass target. The characteristics of the events are similar. However, when compared to the rate of events predicted by scaling the 15 cm target yields, the beam dump data show an excess of 45 +- 16 events. The excess events from the beam dump appear to deposit energies $\geq$ 1 GeV. Their source remains puzzling. Future experiments at the AGS could verify the existence of the effect, decrease the uncertainty in the predicted number of events from 30% to 10% by directly measuring the pion absorption length with a variable density target, search for threshold effects, and measure the sign of the charge of the exiting muons.

41518 (BNL—50947, pp 233-260) **Neutrino oscillation searches at the AGS.** Soukas, A. (Brookhaven National Lab., Upton, NY); Wanderer, P.; Weng, W. 1978.

From Workshop on the AGS fixed target research program; Upton, NY, USA (8 Nov 1978).

A feasibility study of the time evolution of a long-lived ν/sub μ/ beam has been performed. The proton momentum (1.5 GeV/c) was chosen to concentrate the ν/sub μ/ flux at very low energy where all background reactions are kinematically suppressed. Sensitivity to oscillations at large proper times tau varies as l/p (where l is the flight length and p is the momentum of the neutrino) is greatly enhanced by the resulting low neutrino momentum. Possble transformations ν/sub μ/ $\rightarrow$ ν/sub e/ (searched for via ν/sub e/n $\rightarrow$ e^-p reactions) were not observed in an exposure of 2 x 10^{18} protons on target. Ten possible ν/sub μ/n $\rightarrow$ μ^-p events were observed. An upper limit of 3eV comparable to previous limits, can be placed on the mass difference between the two neutrino eigenstates. The accelerator backgrounds are low and the neutrino fluxes copious so that an experiment to approach a mass difference limit of equal to or less than 1eV is currently possible. Future experiments with longer distances and larger masses could reach 0.1eV at the AGS, comparable to the best limits proposed in other accelerator and reactor experiments.

41519 (BNL—50947, pp 262-284) **Conventional meson spectroscopy at AGS energies.** Wicklund, A.B. (Argonne National Lab., IL). 1978.

From Workshop on the AGS fixed target research program; Upton, NY, USA (8 Nov 1978).

Aspects of conventional meson spectroscopy which are amenable to investigation with hadron beams at AGS energies are summarized. Recent experimental findings are reviewed, with an emphasis on the prospects for complementary experiments.

41520 (BNL—50947, pp 285-300) **Hyperon physics at the AGS.** Jensen, D.A. (Univ. of Massachusetts, Amherst, MA). 1978.

From Workshop on the AGS fixed target research program; Upton, NY, USA (8 Nov 1978).

The field of hyperon physics is rich indeed. Not only is there a broad range of phenomena to be studied in terms of the interaction and decays of hyperons, but also the production phenomenology of hyperons has become very exciting. This discussion addresses some of the directions that the study of hyperons has taken in the past and offers comments on some of these problems which seem to hold promise for the present and future. The role that the AGS can play in addressing these problems is discussed.

41521 (BNL—50947, pp 301-306) **Prospects for hadronic production of charmed particles at the AGS.** Gordon, H.A. (Brookhaven National Lab., Upton, NY). 1978.

From Workshop on the AGS fixed target research program; Upton, NY, USA (8 Nov 1978).

Some of the areas of charm spectroscopy are quite well understood: the J/ psi family, the D+-, D^0 and D^*. Other questions are still unsettled: the eta/sub c/, the D^{**}; the F, F^* and all the charmed baryons. From beam dump experiments at the CERN-SPS and Fermilab, the hadronic production of charmed particles is expected to be of the order of $\sim$ 30 μb. The cross section is expected to fall by $\sim$ 100 going from 400 GeV/c to AGS energies. There are two reasons which, in spite of this drop in cross section, may make it favorable to search for charmed particle production at AGS energies: (1) backgrounds in any channel will also fall with energy - maybe faster than the signal; and (2) at AGS energies the cross section for associated production, e.g., π^-p $\rightarrow$ $D^-\Lambda$/sub c/, has its maximum. The charmed particle searches at the AGS, published, in progress and proposed are reviewed.

41522 (BNL—50947, pp 320-324) **MPS capabilities and planned improvements.** Platner, E.D. (Brookhaven National Lab., Upton, NY). 1978.

From Workshop on the AGS fixed target research program; Upton, NY, USA (8 Nov 1978).

The present MPS features include the choice of two beams: the medium energy separated beam (MESB) which produces separated or at least enriched π's, K's or p's from 2 to 10 GeV/c and the high energy unseparated beam (HEUB) which covers 5 to 28.5 GeV/c. Recommended improvements on the existing chamber are discussed along with expected performance improvements.

41523 (CONF-790327—103) **Initial operation of the Argonne superconducting heavy-ion linac.** Shepard, K.W. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 7p. Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

Initial operation and recent development of the Argonne superconducting heavy-ion linac are discussed. The linac has been developed in order to demonstrate a cost-effective means of extending the performance of electrostatic tandem accelerators. The results of beam acceleration tests which began in June 1978 are described. At present 7 of a planned array of 22 resonators are operating online, and the linac system provides an effective accelerating potential of 7.5 MV. Although some technical problems remain, the level of performance and reliability is sufficient that appreciable beam time is becoming available to users.

41524 (CONF-790327—104) **30 μA beam toroid.** Sanders, R.A.; Konecny, R.S. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 5p. Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

Portions of document are illegible.

A standard commercial toroid modified to operate in the zero flux mode has been applied to the monitoring of the 750 keV polarized proton beam at the Zero Gradient Synchrotron (ZGS). The beam parameters are: rise time - 3 ms, pulse width - 15 ms, current - 30 μA. This beam produces a free space flux of H = 8.2 x 10^{-7} oersted at the toroidal core radius. The device has a threshold of 10 μA as determined by system noise and operates with a bandpass of 10 Hz to 2.5 kHz. Ambient electromagnetic interference, predominately 30 Hz, 60 Hz and 200 MHz, was attenuated by use of a cylindrical zero gauss chamber. The addition of the magnetic shield introduced a sensitivity to mechanical vibration which was cured by isolation and stiffening.

41525 (CONF-790327—105) **Intense pulsed neutron source (IPNS-I) accelerator rf system.** Hardek, T.W.; Brandeberry, F.E. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 5p. Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

Portions of document are illegible.

The rf equipment constructed for the IPNS-I accelerator system, formerly called the Zero Gradient Synchrotron (ZGS) Booster II, is described in this report. The accelerator is a first harmonic rapid cycling machine intended to accelerate 3 x 10^{12} protons from 50 MeV to 500 MeV, 30 times per second. The rf system produces a peak accelerating voltage of 22 kV over a 2.2 MHz to 5.3 MHz frequency band. Two single gap ferrite loaded cavities are located 180° around the accelerator and operated 180°

out of phase to provide the desired voltage. High level equipment, low level subsystems and control equipment are covered as well as modifications incorporated after start-up.

41526 (COO—2232A-73) **PWC's and drift chambers at ISABELLE.** Lindenbaum, S.J.; Okuno, H.; Teramoto, Y. (Brookhaven National Lab., Upton, NY (USA); European Organization for Nuclear Research, Geneva (Switzerland); Fermi National Accelerator Lab., Batavia, IL (USA); Kansas Univ., Lawrence (USA); Lehigh Univ., Bethlehem, PA (USA); Northeastern Univ., Boston, MA (USA); Rockefeller Univ., New York (USA)). 1978. Contract EY-76-C-02-2232. 34p. Dep. NTIS, PC A03/MF A01.

The standard technique of measuring the relativistic rise of ionization in gases (total ionization measurement) will give satisfactory results only at higher pressure. The better results can be obtained for lower moments ($p \leqq 15$ GeV/c) or expensive Xe and a very large number of readout channels (of the order of 10^4). Deeper insight into the ionization process and the signal formation may lead to a substantial improvement, but further investigations are needed.

41527 (LA—7683-MS) **Design and operation of the LAMPF Auxiliary Controller. High-speed remote processing on the CAMAC dataway.** Machen, D.R. (Los Alamos Scientific Lab., NM (USA)). Feb 1979. Contract W-7405-ENG-36. 60p. Dep. NTIS, PC A04/MF A01.

A CAMAC Auxiliary Controller has been developed to further the concepts of distributed processing in both process control and experiment data-acquisition systems. The Auxiliary Controller is built around a commercially available 16-bit microcomputer and a high-speed bit-sliced microprocessor capable of instruction execution times of 140 ns. The modular nature of the controller allows the user to tailor the controller capabilities to the system problem, while maintaining the interface techniques of the CAMAC Standard.

41528 (LA—7758-MS) **Beam pulse length and guide field strength parameter study for the autoresonant acceleration proof-of-principle experiment.** Godfrey, B.B.; Faehl, R.J. (Los Alamos Scientific Lab., NM (USA)). Apr 1979. Contract W-7405-ENG-36. 12p. Dep. NTIS, PC A02/MF A01.

Generator and diode problems have reduced electron beam parameters for the proof-of-principle autoresonant collective ion acceleration experiment from 3 MeV, 30 kA, and 200 ns to 2.25 MeV, 15 kA, and 100 ns. This reduction limits acceleration of hydrogen ions to about 4 MeV, if present experimental plans are followed. The output ion energy can be increased to a more acceptable level by reducing the electron beam radius at the diode and by accelerating ions in a weaker guide magnetic field. Analysis further suggests that preacceleration of ions is necessary for efficient trapping in the slow cyclotron waves. The maximum ion current is of order 15 A.

41529 (LBL—8211) **Final report on the Experimental Superconducting Synchrotron (ESCAR).** Lambertson, G.R.; Gilbert, W.S.; Rechen, J.B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1 Mar 1979. Contract W-7405-ENG-48. 119p. Dep. NTIS, PC A03/MF A01.

A summary is presented of the findings from the ESCAR prototype superconducting synchrotron accelerator development project. The report includes description of the Lattice and beam parameters; superconducting magnets, cryostats; refrigeration and cryogenic distribution; vacuum systems; electrical systems; and conventional facilities. (GHT)

41530 (LBL—8342) **Measurements and correction of the PEP interaction region quadrupole magnets.** Main, R.M.; Tanabe, J.T.; Halbach, K. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1979. Contract W-7405-ENG-48. 5p. (CONF-790327—114). Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

Lenses for the intersection regions of PEP must be pure quadrupole over th entire magnet aperture to within $1{:}10^4$. Correction of the magnet and its end fringe regions to this accuracy requires measurement of the field quality (relative field harmonic component amplitudes at the pole radius) to $1{:}10^5$ through the 30th harmonic. Equipment developed for these measurements and the techniques used for field correction are described.

41531 (LBL—8357) **Design/cost of an induction linac for heavy ions for pellet-fusion.** Faltens, A.; Hoyer, E.; Keefe, D.; Laslett, L.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1979. Contract W-7405-ENG-48. 5p. (CONF-790327—119). Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

The physics of the pellet implosion sets stringent conditions on the accelerator driver. The beam energy should be > 1 MJ, the beam power > 100 TW (implying a pulse length ≈ 10 ns), and the specific energy deposition in the pellet > 20 MJ/g. Thus, considerable current amplification is required, e.g. from some 10 amps at the source to perhaps 10 kiloamps at the pellet. Most of this amplification can be accomplished continuously along the accelerator and the remainder achieved at the end by bunching in the final transport lines to the target chamber. A conceptual schematic of an Induction Linac Fusion Driver is shown, which includes an injector, an accelerator-buncher, and a final transport system. Here only the accelerator portion of the driver is discussed.

41532 (LBL—8373) **Magnets in the pep injection lines.** Reimers, R.; Peterson, J.; Avery, R.; Halbach, K.; Kaviany, M.; Lake, A.; Main, R.; Nissen, R.; Singh, J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1979. Contract W-7405-ENG-48. 4p. (CONF-790327—117). Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

Portions of document are illegible.

The electron and positron beams from the Stanford two-mile linear accelerator are brought to the PEP storage ring via two beam-transport lines, each about 225 meters in length. The beam pulses intended for PEP are switched out of the SLAC beam line by a pair of pulsed dipole bend magnets, which deflects them downward into a d.c. dipole magnet, where positron beams are bent into the south line and electrons into the north. See Figure 1. Each line beyond this common d.c. magnet contains 10 principal dipole magnets and 24 d.c. quadrupole magnets. The common beam-splitter magnet and the last dipole in each line are iron-septum (Lambertson-type) magnets, in which regions of strong and weak magnetic field are separated by thin iron septa. The other magnets are of a more conventional design but have design features with cost or size advantages.

41533 (LBL—8871, pp 75-84) **Heavy ion fusion.** Apr 1979. In Accelerator and Fusion Research Division. Annual report, October 1977—September 1978.

The experimental program at Berkeley to develop a large aperture 2 MeV, 1A Cs^+ ion beam is described. A conceptual design and cost procedure for heavy ion induction linacs are covered, and theoretical activities in beam transport, final focusing, and parameter studies are discussed. (GHT)

41534 (LBL—8906) **Strong rare earth cobalt quadrupoles.** Halbach, K. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1979. Contract W-7405-ENG-48. 5p. (CONF-790327—113). Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

General properties as well as specific configurations of a new family of strong Rare Earth Cobalt quadrupoles are discussed.

41535 (LBL—8961) **Bevalac Radiotherapy Facility.** Alonso, J.R.; Howard, J.; Criswell, T. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1979. Contract W-7405-ENG-48. 5p. (CONF-790327—94). Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

Patient Treatment Room at the Bevalac is now in full operation. In the design of this facility, emphasis has been placed on creating an atmosphere appropriate to a clinical facility; the usual features of an irradiation cave have been hidden behind carpets, curtains and paint. Patient positioning is done with a Philips Ram-style couch, with additional fixtures to accommodate a patient in the seated or standing, as well as the supine, position. Dosimetry apparatus, collimators, ion chambers and the beam flattening system used to produce the highly uniform 20 cm diameter therapy field are described.

41536 (SAND—78-2155) **Use of the HERMES II prepulse signal as a timing reference.** Falacy, S.M. (Sandia Labs., Albuquerque, NM (USA)). Mar 1979. Contract EY-76-C-04-0789. 17p. Dep. NTIS, PC A02/MF A01.

A technique of providing a timing signal preceding HERMES II firing time by 0 to 500 ns is described. This timing signal is accurate to within 60 ns of the required time, and the actual error can be measured immediately after each HERMES shot. The timing signal was needed because HERMES II fires with a time accuracy of no greater than 1 μs from the command-to-fire signal. (Timing signals as much as 1.2 μs before HERMES firing are also possible). This technique was developed as the result of a requirement to provide a signal to start a high speed streak camera used to photograph the effects of a HERMES Beam Extraction Experiment in April 1978. The procedure used to start the streak camera using this HERMES II prepulse technique is outlined in the appendix.

41537 (SLAC-PUB—2276) **PEP computer control system.** (Stanford Univ., CA (USA)). Mar 1979. Contract EY-76-C-03-0515. 4p. (PEP-NOTE—286; CONF-790327—124). Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

This paper describes the design and performance of the computer system that will be used to control and monitor the PEP storage ring. Since the design is essentially complete and much of the system is operational, the system is described as it is expected to 1979. Section 1 of the paper describes the system hardware which includes the computer network, the CAMAC data I/O system, and the operator control consoles. Section 2 describes a collection of routines that provide general services to applications programs. These services include a graphics package, data base and data I/O programs, and a director programm for use in operator communication. Section 3 describes a collection of automatic and semi-automatic control programs, known as SCORE, that contain mathematical models of the ring lattice and are used to determine in real-time stable paths for changing beam configuration and energy and for orbit correction. Section 4 describes a collection of programs, known as CALI, that are used for calibration of ring elements.

41538 (SLAC-PUB—2289) **Initial operation of SSRL wiggler in spear.** Berndt, M.; Brunk, W.; Cronin, R.; Jensen, D.; Johnson, R.; King, A.; Spencer, J.; Taylor, T.; Winick, H. (Stanford Univ., CA (USA)). Mar 1979. Contract EY-76-C-03-0515. 4p. (CONF-790327—125). Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

A 3 λ planar, magnetic wiggler has been designed, built, installed and operated in the SPEAR storage ring. Its primary purpose is to provide tunable synchrotron radiation (SR) with a higher energy and intensity than previously available for a new SR beam line just commissioned at the Stanford Synchrotron Radiation Laboratory. Because the magnet operates from 0-18 kG, it should also produce undulator radiation (UR). Since the wiggler influences storage ring operation in both single beam and colliding beam modes, measurements were made of tune changes, emittance changes and energy spreads which are compared to predictions. Significant improvements in luminosity for high energy physics experiments were observed. The ability to do x-ray experiments easily that were not previously feasible at low electron beam energies and currents has also been demonstrated. The basic design, some interesting characteristics of the magnetic measurements and initial operating experience and results are discussed.

41539 (UCRL—82533) **Emittance measurements on field emitter diodes.** Kulke, B.; Kihara, R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 Apr 1979. Contract W-7405-ENG-48. 40p. (CONF-790622—1). Dep. NTIS, PC A03/MF A01.

From Pulsed power conference; Lubbock, TX, USA (12 Jun 1979).

On the basis of time-integrated emittance measurements, several different types of field emitter diodes were characterized at 1 to 3 kA, 1 MeV. These measurements were part of the design effort for the injector system of a linear induction accelerator, to be used as a flash x-ray source at Lawrence Livermore Laboratory. The experimental parameters were the cathode type, the anode mesh texture, the diode spacing and voltage, and the level of collimation of the emerging beam. Experimental results are presented that show that over a wide range, the emittance was proportional to the level of collimation. For any one diode, with the spacing left fixed, the emittance was found to be essentially independent of the diode voltage and current. Differential focusing of different energy beam components affects most strongly the peripheral components of the beam, and strong collimation was found to minimize the effects of momentum spread on the emittance. The lowest emittances (30 to 40 mr-cm at 400 A) were obtained with a foil-type cathode in a ball-over-plane configuration, using an etched tungsten mesh anode, and collimating the beam to one quarter of the total current.

41540 (UCRL-Trans—1569) **Parameter selection criteria and vacuum system design principles of the multicharged ion synchrotron accelerators.** Dmitriev, I.S.; Saksaganskii, G.L.; Shukeilo, I.A. (Nauchno-Issledovatel'skij Inst. Ehlektrofizicheskoj Apparatury, Leningrad (USSR)). Apr 1979. Translation of Preprint B-0407, 1978. 17p. Dep. NTIS, PC A02/MF A01.

The calculation technique of the vacuum parameters of the synchrotron constant-charge heavy ion accelerators is developed. Non-elastic interaction cross sections of the residual gas medium atoms with the accelerated ions are given. Simple and practically convenient dependences are found, permitting to determine the tolerable residual gas concentrations as a beam parameter function for acceleration and storage modes and to select the ultrahighvacuum pumping devices. The technology of obtaining the required pressure $\sim 10^{-10}$ Torr and lower in the synchrotron chambers is briefly described. The table of the designed vacuum parameters of the largest home-made multi-charged ion synchrotrons is presented.

41541 (LA-tr—79-10) **Electrochemical copper coatings for surface finishing of hf resonators.** Weiss, W.D. 1979. Translation source not available. 23p. Dep. NTIS, PC A02/MF A01.

The finishing of the resonators for the UNILAC will take place in bright copper plating baths. The following demands are made of the copper coatings: (1) low surface roughness; (2) homogeneous layer (no pits or pores); (3) good conductivity (high frequency conductivity); (4) low outgas rate; (5) good adhesion; (6) uniform coating thickness distribution. The properties of the coatings which are produced from acid bright copper plating baths as a rule fulfill Conditions 1, 2, 4, and 6. It turned out, however, that there was strong scatter in the conductivities of coatings which were deposited in baths from different producers. Therefore, the attempt was made to explain the causes of this scatter through systematic bath investigations and to prepare baths from which coatings with the highest possible conductivity could be produced.

41542 (LA-tr—79-11) **Planning and construction of the GSI tank copper-plating installation.** Gaiser, H. 1979. Translation source not available. 10p. Dep. NTIS, PC A02/MF A01.

The ion linear accelerators which have been in operation until now have been made of copper sheet or copper-plated steel. For the construction of the UNILAC other alternatives were investigated: (a) full copper construction (electroplating finish); (b) copper plating of the hf current-carrying accelerator elements. The decision for the high-luster copper electroplating was made in 1969. This was preceded by the successful attempt to copper plate an outer resonator conductor made of structural steel which was then subjected to high-performance tests.

41543 (UCRL-Trans—11460) **Study of the superconducting sector cyclotron SUSE at the tandem accelerator of the Munich Accelerator Laboratory.** (Technische Univ. Muenchen, Garching (Germany, F.R.). Physik-Dept.). 1979. Translation source not available. 34p. Dep. NTIS, PC A03/MF A01.

Topics covered include: the superconducting sector cyclotron at SUSE; design of the magnets; design of the cavity resonator; additional equipment; and costs. The planned use of the new system is discussed. (GHT)

41544 **Collective field accelerator.** Luce, J.S. (to Dept. of Energy). US Patent 4,128,764. 5 Dec 1978. Filed date 17 Aug 1977. 6p.

A collective field accelerator which operates with a vacuum diode and utilizes a grooved cathode and a dielectric anode that operates with a relativistic electron beam with a v/γ of $\sim$ 1, and a plurality of dielectric lenses having an axial magnetic field thereabout to focus the collectively accelerated electrons and ions which are ejected from the anode. The anode and lenses operate as unoptimized r-f cavities which modulate and focus the beam.

41545 **Differentially-charged and sequentially-switched square-wave pulse forming network.** North, G.G.; Vogtlin, G.E. (to Dept. of Energy). US Patent Application 913,634. 8 Jun 1978. 10p.

A pulse forming network for delivering a high-energy square-wave pulse to a load, including a series of inductive-capacitive sections wherein the capacitors are differentially charged higher further from the load. Each charged capacitor is isolated from adjacent sections and the load by means of a normally open switch at the output of each section. The switch between the load and the closest section to the load is closed to begin discharge of the capacitor in that section into the load. During discharge of each capacitor, the voltage thereacross falls to a predetermined potential with respect to the potential across the capacitor in the next adjacent section further from the load. When this potential is reached, it is used to close the switch in the adjacent section further from the load and thereby apply the charge in that section to the load through the adjacent section toward the load. Each successive section further from the load is sequentially switched in this manner to continuously and evenly supply energy to the load over the period of the pulse, with the differentially charged capacitors providing higher potentials away from the load to compensate for the voltage drop across the resistance of each inductor. This arrangement is low in cost and yet provides a high-energy pulse in an acceptable square-wave form.

STORAGE RINGS

REFER ALSO TO CITATION(S) 41538

41546 (BNL—0575) **Transverse resistive wall instability of an off-axis ribbon beam in a circular chamber.** Courant, E.D.; Month, M. (Brookhaven National Lab., Upton, NY (USA)). Jun 1978. Contract EY-76-C-02-0016. 37p. Dep. NTIS, PC A03/MF A01.

High energy proton storage rings are designed to make maximal use of the available vacuum chamber aperture. This is dictated primarily by economic considerations. The accumulation of current

in a typical high energy ring creates a rather unusual beam configuration: in particular, a ribbon beam in a circular chamber set well off the central axis. The result is an enhanced resistive wall instability. This could be anticipated from the strong dependence of the current threshold on the chamber radius for a centered beam. For an off-centered beam, one might expect that the relevant replacement for the radius would be the distance of closest approach. The case of a wide ribbon-type beam is treated. The current threshold is obtained as a solution to a coupled oscillator eigenvalue problem. When the beam is small as occurs near the beginning of current stack formation, the problem is reduced to a dispersion relation. Results are expressed in terms of ISABELLE parameters. Some conclusions relevant to the ISABELLE design are presented.

41547 (BNL—25752) **Experimental areas: summary of activity.** Pope, B.G.; Stevens, A.J. (Princeton Univ., NJ (USA); Brookhaven National Lab., Upton, NY (USA)). 1978. Contract EY-76-C-02-0016. 5p. Dep. NTIS, PC A02/MF A01.

Participants were divided into two subgroups: a group to examine the large magnetic facilities and their impact on the design of the so-called facility halls, and a nonfacilities group that studied each of the other interaction regions. This latter group considered, in a time-ordered sequence dictated by the proposed construction schedule, topics associated with the wide-angle hall, open areas, and the small-angle hall. Although these divisions served to define the emphasis of the two subgroups, both sections also considered problems of a more general nature which are relevant, in principle, to all interaction regions. For example, the nonfacilities group discussed the needs for radiation shielding, different modes of beam dumping, requirements for interaction region vacuum chambers, etc., while the facilities group considered the effects of magnetic fields on the beams, the problem of access to central detectors, and the question of experiment mobility. Such topics are grouped under the vague heading General Considerations. Also included, as Appendices, are three BNL technical notes that relate directly to several of the topics studied and were used as source material in many of the discussion groups.

41548 (SLAC-PUB—2281) **Impact of elementary particle physics on storage rings.** Bjorken, J.D. (Stanford Linear Accelerator Center, CA (USA)). 1979. Contract EY-76-C-03-0515. 3p. (CONF-790327—118). Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

The status of elementary particle physics is described, the contribution of machines to the study is discussed and implications for future storage rings are considered. Some comments are offered as to the limits to growth and the prospects for actually producing colored objects other than quarks. (GHT)

41549 (SLAC-PUB—2286) **Single feedback systems for simultaneous damping of horizontal and longitudinal coherent oscillations.** Chao, A.W.; Morton, P.L.; Rees, J.R. (Stanford Linear Accelerator Center, CA (USA)). 1979. Contract EY-76-C-03-0515. 3p. (CONF-790327—115). Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

A complete analysis of the Type (x, $\dot{\delta}$) feedback system is presented using a matrix method. The analyses of other types are similar to that of Type (x, $\dot{\delta}$) and only the results are included. Some comparisons of these types of feedback schemes in terms of power consumptions and the effectiveness in damping the horizontal-betatron and synchrotron oscillations are included. Some effects of position measuring errors on the performance of the feedback systems are also discussed.

INSTRUMENTATION

RADIATION INSTRUMENTATION

41550 **Acoustic response of thin film windows in the environment of an atlas-centaur launch.** Mastronardi, R. (American Science and Engineering, Inc., Cambridge, MA); Gaillardetz, R.; Brissette, R. *SAMPE Q.;* **10**: No. 3, 17-24(Apr 1979).

An exhaustive design development study was performed to correlate the survivability of thin film to various parameters. Film material properties, film thicknesses, unsupported window areas, window aspect ratios, film/frame transitions, film reinforcing techniques, and material grain orientations were all considered. Several thin films were tested to acoustical loads which are expected during an Atlas-Centaur launch of the High Energy Astronomy Observatory Satellites (HEAO).

41551 **Intra-reactor devices for investigation realization, creep, and fatigue during low-cyclic stress.** Miloserdin, Yu.V.; Chechko, V.N.; Kryukov, V.A.; Matushkin, V.A.; Semenov, B.D.; Medvedev, A.A. pp 156-160 of Radiatsionnye effekty izmeneniya mekhanicheskikh svoisty konstruktsionnykh materialov i metody ikh issledovaniya. Pisarenko, G.S. (ed.). Kiev, USSR; Izdatel'stvo Naukova Dumka (1977). (In Russian)

From 2. All-Union conference on the radiation effects of the change in the mechanical properties of construction materials and methods of investigating them; Kiev, USSR (Apr 1976).

An examination is made of the designs of two types of devices and a method of testing construction materials in the IRT-2000 reactor at the Moscow Physics Institute. The GKR-3 device is designed for investigating resistance to single and alternating strain, cyclic creep and relaxation during the distortion of uniform cyclindrical samples in the temperature range of 200 to 300°C. The KR-4 device makes it possible to test six samples simultaneously for low-cyclic fatigue at elevated temperatures. 3 references, 2 figures.

GENERAL DETECTORS AND MONITORS

41552 (CONF-781174—5) **Instrumentation for fission cross section measurements on actinides.** Dabbs, J.W.T. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 16p. Dep. NTIS, PC A02/MF A01.

From Conference on the nuclear data of higher plutonium and americium isotopes for reactor applications; Upton, NY, USA (20 Nov 1978).

The paper describes three developments in instrumentation for actinide fission cross section measurements at ORNL. Two of these are related to the problem of detecting a few fission events in the presence of an extremely large alpha background. Time-of-flight measurements of neutron fission cross sections on highly alpha active actinide samples at electron linear accelerators have been hindered by pileup of alpha pulses in the amplifier, a noise contribution which is normally overwhelming. In the past, such measurements could only be made using underground nuclear explosions; indeed, much of the present knowledge of the fission cross sections of highly alpha-active nuclides comes from such measurements. The third development is an improved neutron beam monitor for time-of-flight measurements.

41553 **Energy independent uniformity improvement for gamma camera systems.** Lange, K. (to General Electric Co.). US Patent 4,142,102. 27 Feb 1979. Filed date 20 Jun 1977. 12p.

In a gamma camera system having an array of photomultiplier tubes for detecting scintillation events and preamplifiers connecting each tube to a weighting resistor matrix for determining the position coordinates of the events, means are provided for summing the signals from all photomultipliers to obtain the total energy of each event. In one embodiment, at least two different percentages of the summed voltage are developed and used to change the gain of the preamplifiers as a function of total energy when energies exceed specific levels to thereby obtain more accurate correspondence between the true coordinates of the event and its coordinates in a display.

HIGH ENERGY PHYSICS INSTRUMENTATION

REFER ALSO TO CITATION(S) 41522

41554 (COO—3064-031) **Use of a low energy proton accelerator for calibrating a large NaI(Tl) array in a high energy physics experiment.** Kirkbride, G.I.; O'Reilly, J.G.; Tompkins, J.C. (Stanford Univ., CA (USA). Aerosol Lab.). 1978. Contract EY-76-C-02-3064. 4p. (CONF-7811124—1). Dep. NTIS, PC A02/MF A01.

From IEEE crystal ball collaboration; Denton, TX, USA (Nov 1978).

The use of a 500 keV Van de Graaff proton accelerator to produce γ-rays in the range 4 - 18 MeV via nuclear reactions for the purpose of calibrating a large NaI(Tl) crystal array is reported. Data analysis indicates an energy calibration to ~ 1% over this range.

RADIOMETRIC INSTRUMENTS

REFER ALSO TO CITATION(S) 40069

41555 (INIS-mf—4493, pp 83-88) **In-situ testing of fresh concretes in nuclear reactor biological shielding.** Hoenig, A. (VUT - Ustredni Stredisko Radiacni Defektoskopie, Brno (Czechoslovakia)). 1977. (In Czech).

From Nondestructive testing in the building industry; Brno, Czechoslovakia (7 Jun 1977).

A radiometric densimeter is briefly described developed at the Brno Technical University for in-situ monitoring of the density

of fresh concrete. Its operation is described during the construction of two heavy 41 MeV betatrons of oncological institutes, one linear accelerator and two nuclear reactors in Czechoslovakia, and in testing concretes of primary and secondary shieldings during the construction of a nuclear power plant in Hungary.

41556 Infrared radiometer employing a gallium arsenide injection photodiode. Abramyan, Y.A.; Anisimova, I.D.; Kalyaeva, V.P.; Mirzabekyan, E.G.; Mikhailov, I.I.; Simonyan, R.G.; Stafeev, V.I. *Sov. J. Opt. Technol. (Engl. Transl.);* **45**: No. 9, 602(Sep 1978).

The electronics of a modulation radiometer are described. The threshold sensitivity was determined. (AIP)

MISCELLANEOUS INSTRUMENTS

REFER ALSO TO CITATION(S) 40062, 40064, 40065, 40066, 40067, 40068, 40070, 40071, 40073, 40077, 40078, 40080, 40093, 40101, 40116, 40118, 40196, 40199, 40793, 40804, 40805, 41576, 41579, 41590, 41617

41557 (ANL—78-62, pp 724-737) **Bed level determination for on-line data acquisition and process control.** Fuchs, W.; Yavorsky, P.M. (Pittsburgh Energy Research Center, PA). 1978.

From Symposium on instrumentation and control for fossil demonstration; Newport Beach, CA, USA (19 Jun 1978).

Bed level determination by time domain reflectometry (TDR) involves measuring the transit time of an electromagnetic signal as it travels down an electrode extending into the bed and is partially reflected by the bed material. This method is, in principle, simple and straightforward. The electronic components are commercially available as off-the-shelf items. The output of the TDR sample head, which is a rapidly changing signal, is transmitted to a computer system via an analog-to-digital converter. The data are processed and the result representing the bed height is returned for display, storage, or process control.

41558 (DP—1489, pp 141-142) **Apparatus for freeze drying of biologic and sediment samples.** Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

Freeze drying to obtain water from individual samples, though not complicated, usually requires considerable effort to maintain the cold traps on a 24-hr basis. In addition, the transfer of a sample from sample containers to freeze-dry flasks is usually made with some risk of contamination to the sample. If samples are large, 300 g to 600 g, usually several days are required to dry the samples. The use of an unattended system greatly improves personnel and drying efficiency. Commercial freeze dryers are not readily applicable to the problems of collecting water from individual samples, and lab-designed collectors required sample transfer and continual replenishment of the dry ice. A freeze-dry apparatus for collecting water from individual sediment and/or biological samples was constructed to determine the tritium concentrations in fish for dose calcaluations and the tritium distribution in sediment cores for water movement studies. The freeze, dry apparatus, which can handle eight samples simultaneously and conveniently, is set up for unattended 24-hr operation and is designed to avoid sample transfer problems.

41559 (LA-UR—79-548) **Fiber-optic coupled pressure transducer.** Tallman, C.R.; Wingate, F.P.; Ballard, E.O. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 11p. (CONF-790505—13). Dep. NTIS, PC A02/MF A01.

From 25. ISA international instrumentation symposium; Anaheim, CA, USA (7 May 1979).

A fiber-optic coupled pressure transducer was developed for measurement of pressure transients produced by fast electrical discharges in laser cavities. A detailed description of the design and performance will be given. Shock tube performance and measurements in direct electrical discharge regions will be presented.

41560 (PNL—2850(Pt.3), pp 1.21) **Procedure for altitude compensation for a flame-photometric sulfur analyzer.** Hales, J.M.; Easter, R.C.; Lee, R.N. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

A calibration scheme, which applies to the Meloy-285 sulfur analyzer, is described. This scheme allows reliable instrument calibration, which automatically compensates for variations in instrument response with altitude.

41561 (PNL—2850(Pt.3), pp 1.23-1.24) **Improvement of a standard NO/NO/sub x/ monitor for aircraft research.** Hales, J.M.; Busness, K.M. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

A standard NO/NO/sub x/ analyzer has been modified to improve its sensitivity and specificity. This has resulted in a factor-of-ten improvement in threshold sensitivity level (0.5 ppB).

41562 (PNL—2873) **Develop the application of a digital memory acoustic emission system to aircraft flaw monitoring.** Hutton, P.H.; Skorpik, J.R. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Dec 1978. Contract EY-76-C-06-1830. 74p. Dep. NTIS, PC A04/MF A01.

The purpose of the program is to evaluate the use of the acoustic emission (AE) technique to provide a definitive continuous monitor of fatigue crack growth in a critical aircraft structural member. The program started in September, 1977, with Phase I consisting of defining technical and procedural details and developing and fabricating an AE monitor system. A unique AE monitoring system was fabricated and laboratory tested. It utilizes a source isolation feature to distinguish AE signals originating from an identified area of interest. Two parameters of AE information are recorded on one solid state digital memory for later retrieval and analysis. Phase I was completed in April, 1978. Phase 2 was concerned with installing and testing the AE monitoring system in an aircraft. Installation was made in RAAF Macchi 326 aircraft A7-201 during a major maintenance overhaul. The system is monitoring AE from fatigue cracks in a fastener hole in the tension member of the wing structure center section continuously during flight. Installation was completed in August, 1978, with four test flights to evaluate system performance and make necessary adjustments. Follow-up support to the Australian Aeronautical Research Laboratory (ARL) on this program is continuing.

41563 (RFP—2807) **Study of dioctyl phthalate particles (DOP) generated in penetrometers and the devices used currently to measure their size.** (Atomics International Div., Golden, CO (USA)). 1978. Contract EY-76-C-04-3533. 5p. (CONF-780819—25). Dep. NTIS, PC A02/MF A01.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Portions of this report are illegible.

The present method of measuring the 0.3 micrometer particle has been of concern to many users of Monodispersed DOP Penetrometers. Verification of the 0.3 micrometer is totally dependent upon the photoelectric particle-size meters and the capabilities of the individual calibrating the meters and associated electronics.

41564 Photoacoustic effect: 1880 to the present. McClelland, J. (Ames Laboratory, Iowa State University, Ames, Iowa 50011). *Opt. News;* **5**: No. 1, 19-23(Jan 1979).

The generation of acoustic signals by light is briefly reviewed. The spectroscopic instrumentation involved in studying the photoacoustic effect is discussed as are applications of the process to gas and condensed matter measurements. (AIP)

41565 (RFP-Trans—270) **Gauging and feeling system for multi-coordinate measuring instruments.** Herzog, K. 1977. Translated from German brochure. (CONF-7709176—1(Trans)). 23p. Dep. NTIS, PC A02/MF A01.

From 8. workshop of the Institute for Production Engineering and Automation 1977 exchange of experience on the three-coordinate measuring instrument; Stuttgart, F.R. Germany (14 Sep 1977).

Automated multicoordinate measuring instruments for machined parts are discussed.

WELL LOGGING INSTRUMENTATION

41566 (UCRL—81657) **Calibration of a neutron log in partially saturated media.** Hearst, J.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 3 Nov 1978. Contract W-7405-ENG-48. 54p. (CONF-790605—3). Dep. NTIS, PC A04/MF A01.

From 20. annual logging symposium; Tulsa, OK, USA (3 Jun 1979).

An epithermal neutron logging sonde has been calibrated in a facility containing nine samples. Each sample represents a different combination of bulk density and water content. The facility simulates very large (approximately 2-m-diameter) dry holes and 30-cm-diameter dry and water-filled holes. The neutron log data are affected not only by water content, but also by bulk density and the gap between the sonde and the wall of a dry borehole. For large holes and the wet 30-cm hole, count rate generally decreases with increasing bulk density. For the dry 30-cm hole, however, the count rate increases with increasing density. Algorithms for fitting count rate to water content, density, and gap have been developed for a shielded and unshielded logging sonde. By using this algorithm, it is

possible for the first time to log for water content in dry holes in partially saturated media and obtain good agreement with sample data.

EXPLOSIONS AND EXPLOSIVES

CHEMICAL

41567 (MHSMP—79-23) **Analysis of PBX 9501 by high speed liquid chromatography.** Teter, A.C. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). Mar 1979. Contract AC04-76DP00487. 7p. Dep. NTIS, PC A02/MF A01.

A method for the analysis of PBX 9501 by high speed liquid chromatography was developed. Relative standard deviations for the major components were less than 4%. Separation was made on a 50 cm x 2.6 mm ID amino Sil-X column. A mixture of 80% tetrahydrofuran and 20% isopropanol was used for the mobile phase. Analysis run time was 5.5 minutes. Detection was via ultraviolet spectrometer at 220 nm. A separation of the nitroplasticizer components was also accomplished using a different mobile phase solvent combination.

41568 (MLM—2596) **Investigations of TiH/sub x//$KC10_4$ and boron/$CaCrO_4$ pyrotechnic systems by pulsed NMR.** Attalla, A.; Craft, B.D.; Salerno, R.F.; Franchetti, V.M. (Mound Facility, Miamisburg, OH (USA)). 25 Apr 1979. Contract EY-76-C-04-0053. 26p. Dep. NTIS, PC A03/MF A01.

Moisture measurements using a pulsed nuclear magnetic resonance technique were initiated to support a detonator corrosion investigation. Results using this technique led to process changes which decreased corrosion rates. This technique is presently used routinely to monitor production samples and aid in process development of new materials. Moisture analyses were performed on $TiH_{0.15}$ metal powder, $TiH_{0.65}$ and $TiD_{0.65}$ powders, $TiH_{0.15}/KClO_4$ powder and pressed pellets, $TiH_{0.65}/KClO_4$ pressed pellets, $KClO_4$ powder, Kapton discs, empty ceramic charge holders, boron powders and $CaCrO_4$ powder. Desorption conditions were studied. Moisture adsorption rates of $TiH_{0.15}$ metal powder, $TiH_{0.15}/KClO_4$ pressed pellets, Kapton discs, and boron powder were determined. $TiH_{0.15}/KClO_4$ pressed pellets adsorb moisture more slowly than the loose metal powders; and conversely, the pellets desorb less readily. Dried Kapton discs adsorb moisture linearly during the first 30 min of exposure to relative humidity. No appreciable mositure could be detected in dry and exposed $TiH_{0.65}$ powder by NMR. Boron powders were found to adsorb moisture readily and desorb on exposure to desiccants. No correlation could be found between moisture adsorption capacity of the boron powders and surface area, particle size, or elemental composition.

41569 (UCRL—13976) **Characterization of initiation and detonation by Lagrange gage technology.** Cowperthwaite, M.; Rosenberg, J.T. (Alaska Dept. of Community and Regional Affairs, Kenai (USA). Div. of Community Planning). Dec 1978. Contract W-7405-ENG-48. 52p. Dep. NTIS, PC A04/MF A01.

Experimental and theoretical studies on the Lagrange gage and analysis techniques for determining constitutive relationships and energy release rates in shocked explosives were performed. The experimental effort supported the Lawrence Livermore Laboratory (LLL) program to develop Lagrange gage technology for measuring Lagrange histories in shocked reacting explosives. In the LLL program, a stress gage package was developed for the explosive environment, preliminary sets of Lagrange pressure histories were recorded in shocked PBX-9404 and TATB, and particle velocity histories were recorded in shocked PBX-9404. In the theoretical effort the similarity solution, based on the initiation of PBX-9404, was examined to gain insight into the hydrodynamics of shock initiation in condensed explosives. Propositions were formulated for deducing hydrodynamic flow properties for a series of Lagrange pressure and particle velocity histories exhibiting maxima. These propositions were used to establish the phenomenology of the shock initiation process in PBX-9404 from the experimental pressure histories recorded at LLL. A Lagrange analysis was performed with the model solution to formulate and test methods for handling Lagrange gage records with pressure and particle velocity peaks similar to those exhibited by PBX-9404.

41570 (UCRL-Trans—11449) **Decomposition heats of explosives analyzed with differential scanning calorimeter using sealed cells.** Itho, M.; Yoshida, T.; Nakamura, M.; Uetake, K. Translated from *Kogyo Kayaku;* **38**: No. 1, 17-23(1977). 17p. Dep. NTIS, PC A02/MF A01.

Sealed sample cells for differential scanning calorimeters (DSC) were prepared from stainless steel and used to analyze the thermal decomposition of explosives. It was found that the susceptibility of an explosive to thermal decomposition could be evaluated from the temperature at which decomposition began, and the decomposition characteristics could be estimated from the shape of the DSC thermogram.

NUCLEAR

41571 (AD-A—059919) **Thermonuclear effects on sandwich-type structures. Final report, 1 April-30 November 1977.** Sparling, C.; Schibler, J. (Rockwell International Corp., Los Angeles, CA (USA)). 1 Dec 1977. Contract DNA001-77-C-0092. 47p. NTIS PC A03/MF A01.

Presence of internal cell pressure during thermal nuclear pulse exposure in honeycomb sandwich structures has been demonstrated. The source of this cell pressure has been shown to be a combination of component outgassing, and the effects of heating a sealed gas (Boyle's law). Cell pressure tests were run at 10 to 50 cal/cm. (Author)

41572 (COO—3462-15) **Fission- and alpha-track study of biogeochemistry of plutonium and uranium in carbonates of bikini and enewetak atolls. Final report.** Levy, Y.; Friedman, G.M.; Miller, D.S. (Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Geology). 31 Dec 1978. Contract EY-76-S-02-3462. 16p. Dep. NTIS, PC A02/MF A01.

Results of the analysis of uranium concentrations in the 8 coral heads sampled from the Bikini and Enewetak lagoons lead to the following conclusions: (1) no parallel increase in uranium concentration was found in the corals contaminated by Pu and Am; (2) in the noncontaminated corals, the fission track analysis shows wider ranges of uranium concentrations (1.8 to 3.1). Thus, in the corals not contaminated by Pu and Am, uranium concentrations similar to the uranium concentration in the contaminated corals were found; (3) uranium content in all corals analyzed was rather homogeneously distributed, i.e., no hot spots, stars, or areas differing in concentration by more than a few percent were detected by the fission track analyses.

41573 (UCRL—52648) **Analysis of slifer data from underground explosions.** Heusinkveld, M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Jan 1979. Contract W-7405-ENG-48. 44p. Dep. NTIS, PC A03/MF A01.

A formula describing the distance—time relationship of a shock wave moving outward from an underground explosion is derived. Calculated results are compared with those computed using the LASL and BOTE formulas and with slifer data obtained from field experiments. For many of the field events, the derived curve provides a better fit than do the LASL or BOTE formulas. Methods are presented for the determination of the detonation energy W under three conditions: (a) where time and distance are known accurately; (b) where there is an unknown offset of time and distance; and (c) where there is an unknown offset of both time and distance. These methods are applied with moderate success to a set of (t,r) data supplied by Goldwire.

CIVIL USES

41574 (SAND—78-2045C) **Evidence for gravity scaling and implications for explosion craters.** Chabai, A.J. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 25p. (CONF-790609—1). Dep. NTIS, PC A02/MF A01.

From 6. ISMABS conference; Cahors, France (25 Jun 1979).

Crater data have been examined from recent hypervelocity impact and chemical explosion experiments conducted in accelerating frames. Data have been identified from experiments for which the conditions of similitude have been very nearly achieved. Examination of these data from similar experiments indicates that fourth-root or gravity scaling is the rule which best relates crater dimensions to the energy release of impacting projectiles or explosives. Implications for chemical and nuclear explosion cratering are that in model experiments where the gravitational field is constant the specific energy and dimensions of the explosive must be scaled as the fourth-root of explosion energy release. Additionally, medium properties must be appropriately scaled in similar experiments. Because of the impracticability of realizing the constraints imposed on model experiments by similitude requirements attention in future experiments should be focused on the sources of similarity violation and their influence on empirical relationships derived from experiments. Experiments in accelerating frames with both explosive sources and hypervelocity impact projectiles offer one means for investigating effects of similitude violation. To further elucidate the question of crater scaling, experiments in accelerating frames may be conducted which most nearly achieve the conditions of similitude required.

WEAPONRY

41575 (SAND—78-1700) **Feasibility studies for crowbarring one megavolt on the LILI facility.** Parker, R.L. (Sandia Labs., Albuquer-

que, NM (USA)). Apr 1979. Contract EY-76-C-04-0789. 36p. Dep. NTIS, PC A03/MF A01.

A technique using a trigatron for crowbarring the energy in a megavolt Marxed capacitor bank into an LR load for simulating low probability, high amperage lightning strokes has been verified as feasible by testing on the LILI facility.

41576 (UCRL—81771) **Fast recovery strain measurements in a nuclear test environment.** Kitchen, W.R.; Nauman, W.J.; Vollmer, D.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Apr 1979. Contract W-7405-ENG-48. 25p. Dep. NTIS, PC A02/MF A01.

The recovery of early-time (50 μs or less) strain gage data on structural response experiments in underground nuclear tests has been a continuing problem for experimenters at the Nevada Test Site. Strain measurement is one of the primary techniques used to obtain experimental data for model verification and correlation with predicted effects. Peak strains generally occur within 50 to 100 μs of the radiation exposure. Associated with the exposure is an intense electromagnetic impulse that produces potentials of kilovolts and currents of kiloamperes on the experimental structures. For successful operation, the transducer and associated recording system must recover from the initial noise overload and accurately track the strain response within about 50 μs of the nuclear detonation. A gaging and fielding technique and a recording system design that together accomplish these objectives are described. Areas discussed include: (1) noise source model; (2) experimental cassette design, gage application, grounding, and shielding; (3) cable design and shielding between gage and recorder; (4) recorder design including signal conditioner/amplifier, digital encoder, buffer memory, and uphole data transmission; and (5) samples of experimental data.

EXPLOSION DETECTION

41577 (LA-tr—79-7) **Study of the spectra of the initial seismic signal after a subterranean nuclear explosion. Determination of the attenuation coefficient in the granite.** Duclaux, F. Translated from *Pure Appl. Geophys.;* **85**: No. 11, 75-89(1971). 19p. Dep. NTIS, PC A02/MF A01.

From the spectral amplitudes obtained at several distances from underground explosions for several values of the emitted energy, the same spectrum was calculated on the sphere where the seismic signal is supposed to begin. This spectrum becomes more flat if the energy becomes smaller. A comparison between the spectra which are obtained at several distances, shows that the exponential attenuation coefficient is proportional to the frequency. This confirms the hypothesis of a constance of the quality factor Q.

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

BASIC STUDIES

41578 (PNL—2850(Pt.3), pp 3.1-3.3) **Direct method of adjusting windfields over complex terrain.** Huang, C.H.; Drake, R.L. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

In this preliminary study, a generalized, mass-consistent model was developed to study the airflow over complex terrain in a conformal space (terrain-following coordinate system). The methodology used in this model offers flexibility, because it is not based on potential flow approaches or restricted to a particular space. Thus, the nature and physics of the airflow over complex terrain can be easily realized through numerical experiments with the model.

41579 (PNL—2850(Pt.3), pp 3.6-3.10) **Insolation and turbidity measurements at Hanford.** Laulainen, N.S.; Kleckner, E.W.; Michalsky, J.J.; Thorp, J.M. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

From observations obtained at the Rattlesnake Observatory and the Hanford Meteorological Station, the redistribution of solar radiation as a result of aerosols in the lowest 1 km of the earth's atmosphere has been examined using several types of solar radiation measuring instruments. Large turbidity excursions are observed with high values associated with stagnant air masses and low values associated with frontal passage. Turbidities show variations in color dependence that arise because of changes in particle size distribution.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 40132, 40181, 40200, 40220, 40323, 40395, 40407, 40419, 41626, 41636, 41638, 41671, 41673, 41677, 41760, 42149

41580 (BDX—613-2190) **Environmental summary for Calendar Year 1978.** (Bendix Corp., Kansas City, MO (USA)). Apr 1979. Contract EY-76-C-04-0613. 17p. Dep. NTIS, PC A02/MF A01.

Environmental monitoring for significant non-radioactive pollutants was conducted to allow evaluation of effluent effects on the environs of the Federal Complex. Ambient air monitoring at three monitoring stations, has indicated a negligible environmental impact on regional air quality from the operations of the Kansas City Plant. Stack emission testing of the powerhouses demonstrated that airborne powerhouse pollutant discharges are only significant when fuel oil rather than natural gas is consumed. Existing Kansas City, Missouri, air pollution control regulations for both particulate matter discharges and sulfur dioxide fence-line concentrations have been evaluated and are being met. More frequent gas curtailments are a national trend. As a result, greater quantities of fuel oil are being used. Air pollution control measures, however, are being budgeted as appropriate to assure regulatory compliance. Contributions of non-radioactive pollutants to the water environment are determined by monitoring the four outfalls discharging effluents to the surface waters. The results of stream monitoring have indicated that discharges to Indian Creek and Blue River have no adverse effect on the pollutant levels in the streams. Plant effluents discharging to the city sanitary sewer have been determined to be within applicable city regulations and Missouri effluent guidelines for industrial discharges to municipal sewer systems. The sanitary sewer effluent includes both sanitary and industrial discharges. Industrial effluents from the wastewater lagoon system also are monitored. No operations result in radioactive releases from the Kansas City Plant. (ERB)

41581 (DP—1489, pp 45-49) **Energy balance of a pine forest.** Murphy, C.E.; Dexter, A.H. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

Studies of the energy balance of a pine forest were initiated at the Savannah River Laboratory (SRL) to gain information on the exchange of gaseous materials between the atmosphere and the forest ecosystem. This information allows better estimates of the deposition velocities of gaseous pollutants necessary for plume calculations and ecosystem modeling studies. Studies to date show that the exchange of water vapor is influenced most by diffusion resistances associated with the vegetative canopy. Vegetative and atmospheric diffusion resistance vary diurnally, with high values occurring at night and low values observed during the day. Thus, water vapor exchange is greatest during the daylight hours. Future plans include measurements of exchange of other gases such as carbon dioxide and sulfur dioxide.

41582 (DP—1489, pp 207-210) **Three-dimensional modeling of pollutant releases using second-order moments.** Pepper, D.W. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

By using data obtained from the SRP seven-tower mesonetwork and a linear interpolation scheme, a three-dimensional wind field can be created. To insure mass consistency, a Sasaki variational treatment of the equation of continuity is performed. A three-dimensional variable-grid strongly implicit procedure is used to solve the modified continuity equation (a Poisson equation containing Lagrangian multipliers to adjust the velocity field). A link-up between the IBM-360/195 computer system and a PDP-11/40 minicomputer permits the wind field and concentration contours to be displayed on a cathode-ray tube and printed at opportune time intervals. A concentration emission situated within a cell (point source) is initially calculated using a separate, parallel, Gaussian puff/plume calculation to establish a cell distribution. Once the initial distribution is established, the contributions from the point source are incorporated within the three-dimensional model (providing the puff-plume has grown sufficiently large to be approximated by a few shallow regions of concentration).

41583 (DP—1489, pp 221-222) **Computational systems in support of environmental sciences.** Suich, J.E. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

Geographical anaysis and display routines have been developed over the past several years at the Oak Ridge National Laboratory (ORNL) in support of Regional Planning and Environmental Studies. These routines are being systematized at ORNL. The package is being installed at the Savannah River Laboratory (SRL) as a geographical data management and display subsystem to inerface

with computational modules in JEREMIAH and directly with users under JUDGES. An interactive graphics program for use in watershed modeling is being developed at Battelle-Pacific Northwest Laboratories for pollutant transport studies. SRL will acquire this program for use under the JEREMIAH/JUDGES systems. SRL, in a DOE-wide collaborative effort, has adopted a standard magnetic tape exchange format. A first draft proposal of a standard format for geographic data exchange has been developed within this same DOE project. The JOSHUA system data definitions were interfaced to this standard with some restrictions. Data in this self-loading standard format are being exchanged for the alternate fuel technologies (AFCT) program. Data being developed under the AFCT program are being loaded into a dose-effects data base representing the southeastern United States. This data base will be integrated with the JEREMIAH system for future studies.

41584 (DP—1489, pp 225-227) **Data from an instrumented navigational light tower off the Savanah River estuary.** Hayes, D.W.; Dicks, A.S.; Blanton, J.O. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

An oceanographic and meteorological instrumentation system operating on the Savannah Navigational Light Tower is providing synoptic information on ocean temperatures, currents, tides, and meteorological conditions. The Savannah Navigational Light Tower, an unmanned U.S. Coast Guard tower, is located about nine miles off Savannah Beach, Georgia, in about 16 m of water. The tower is currently instrumented to measure and record water temperatures from six depths, water velocities at two depts, tides, air temperature, barometric pressure, and wind speed and velocity at two heights. The outputs are currently being recorded every 10 minutes. These data aid in the interpretation of the processes governing pollutant transport in the Savannah River marine region and support other DOE funded programs in the southeastern United States. This past year, computer programs were written and are being tested for processing the raw data from the tower and for performing correlative analysis of the data.

41585 (EPRI-EA—1031(Vol.2)) **Nitrogen oxide interferences in the measurement of atmospheric particulate nitrates.** Rohlack, L.A.; Hawn, W.C.; Williams, K.R.; Parsons, T.P. (Radian Corp., Austin, TX (USA)). Mar 1979. 74p. Dep. NTIS, PC A04/MF A01.

This report presents the results of an experimental program to evaluate the validity of reported atmospheric particulate nitrate concentrations using high-volume (Hi-Vol) sampling techniques. Laboratory and field experiments were conducted to determine the extent of interference that gaseous nitrogen oxides introduce in the atmospheric nitrate determinations. The formation of artifact nitrate was studied as a function of time, filter type, filter pretreatment, particulate type and loading, temperature, humidity, and nitric oxide, nitrous oxide, and ozone concentrations. The highest nitrate values were measured on glass-fiber filters at high nitric oxide and high humidity levels and low temperatures. In fact, the artifact nirate formed during the collection of ambient samples at these worst-case conditions may be the major contributor to measured particulate nitrate values. The sorption of gaseous nitrogen oxides was reduced from 50 to 100% on teflon, polycarbonate, and acid-washed, glass-fiber filters compared to untreated glass-fiber filters.

41586 (ORNL/TM—6869) **Selected constituents in the smokes of foreign commercial cigaretts: tar, nicotine, carbon monoxide, and carbon dioxide.** Jenkins, R.A.; Quincy, R.B.; Guerin, M.R. (Oak Ridge National Lab., TN (USA)). May 1979. Contract W-7405-ENG-26. 62p. Dep. NTIS, PC A04/MF A01.

The tar, nicotine, carbon monoxide, and carbon dioxide contents of the smokes of 220 brands of foreign commercial cigarettes are reported. In some instances, filter cigarettes of certain brands were found to deliver as much or more smoke constituents than their nonfilter counterparts. Also, data indicated that there can be a great variation in the tar, nicotine, or carbon monoxide content of the smoke of samples of a given brand of cigarettes, depending on the nation in which they are purchased. 24 tables.

41587 (ORNL/TM—6870) **Selected constituents in the smokes of U.S. commercial cigaretts: tar, nicotine, carbon monoxide and carbon dioxide.** Jenkins, R.A.; Quincy, R.B.; Guerin, M.R. (Oak Ridge National Lab., TN (USA)). May 1979. Contract W-7405-ENG-26. 46p. Dep. NTIS, PC A03/MF A01.

One hundred twenty-one brands of United States commercial cigarettes were analyzed for their deliveries of tar, nicotine, carbon monoxide, and carbon dioxide under standard analytical smoking conditions. The sample included both filter and nonfilter cigarettes. Comparisons of carbon monoxide deliveries over the range of observed tar deliveries indicated a very high correlation between CO and tar for filter cigarettes, but nonfilter cigarettes tended to produce much less CO than would have been predicted from their tar deliveries. Comparison of ORNL nicotine values for specific brands with those determined by the Federal Trade Commission yield no statistically significant differences between laboratories. 4 figures, 6 tables.

41588 (PB—287178) **Multimedia Environmental Control Engineering Handbook: methodology and sample summary sheets. Final task report, December 1976.** Borer, T.C.; Karr, A.W. (Cameron Engineers, Inc., Denver, CO (USA)). Sep 1978. Contract EPA-68-02-2152. 282p. NTIS PC A13/MF A01.

The report describes a development methodology and provides sample summary sheets for a Multimedia Environmental Control Engineering Handbook. This effort is part of EPA's documentation of the environmental effects of many industrial processes (including those involving fossil fuels) to determine where environmental controls are needed and, if needed, which existing controls are applicable or may have to be developed. Each main classification of the Handbook is subdivided to specific devices or processes. The completed Handbook would require that each device have a summary sheet filled out to include appropriate identification, pollutants controlled, process description, application range, capital costs, operating costs, operating efficiencies, environmental problems, special notes, manufacturers/suppliers, and references. The completed Handbook is intended to be a reference to be used as a guide to potential solutions, and alternatives to environmental problems.

41589 (PB—287197) **An executive summary: 16 air and water pollution issues facing the nation. Report to the congress.** (General Accounting Office, Washington, DC (USA). Community and Economic Development Div.). 11 Oct 1978. 45p. NTIS PC A03/MF A01.

Controlling air and water pollution could cost the Government and industry $423 billion from 1975 to 1984. Officials in the public and private sectors are raising questions such as: How much environmental protection is needed, When is it needed, What is the best way of getting it, and What price is the Nation willing to pay. With these thoughts in mind, GAO studied national air and water pollution control goals and strategies to determine strengths and weaknesses and to identify possible alternatives. During its study GAO identified 16 major environmental pollution issues, performed extensive fieldwork, expressed its view on each issue, and recommended congressional and agency action, where appropriate.

41590 (PNL—2850(Pt.3)) **Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3, Atmospheric sciences.** Simpson, C.L. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Feb 1979. Contract EY-76-C-06-1830. 116p. Dep. NTIS, PC A06/MF A01.

Separate abstracts were prepared for the 39 papers presented in the report. An author index and lists of publications and presentations are also included. (HLW)

41591 (PNL—2850(Pt.3), pp 1.1) **Pollutant transformations over Lake Michigan.** Alkezweeny, A.J.; Arbuthnot, D.R.; Busness, K.M.; Easter, R.C.; Hales, J.M.; Lee, R.N.; Young, J.M. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

An aircraft, a chartered boat, and a constant altitude balloon were used to study pollutant transformations over Lake Michigan in a Lagrangian frame of reference. The experiments were conducted during the summer under strong atmospheric stability where diffusion and dry deposition of pollutants can be neglected.

41592 (PNL—2850(Pt.3), pp 1.2-1.3) **Aerosol formation in urban plumes over Lake Michigan.** Miller, D.F. (Battelle Columbus Labs., Ohio); Alkezweeny, A.J. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

To determine the oxidation rates of SO_2 to sulfate in urban plumes, data from three field experiments, conducted over Lake Michigan, were analyzed and interpreted, using a photochemical smog model. A maximum rate of 4 to 6%/hr was found, and it appeared to occur around noon. Using conservative estimates for the rates of the SO_2 reactions with free radicals, the model predicted maximum rates of 4 to 5%/hr. According to the modeling results, OH and RO_2 radicals were each responsible for about 40% of the oxidation during midday, while HO_2 contributed about 20%.

41593 (PNL—2850(Pt.3), pp 1.3-1.4) **PNL aircraft measurements in the AMBIENS study.** Hales, J.M.; Lee, R.N.; Alkezweeny, A.J. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

This report presents a brief description of the Atmospheric Mass Balance Industrial Emitted and National Sulfur (AMBIENS) field study, which was performed in central Indiana during October

of 1977. Special emphasis is placed on a description of the Pacific Northwest Laboratory (PNL) aircraft operations.

41594 (PNL—2850(Pt.3), pp 1.4-1.6) **Summary of the PNL aircraft flights during the MAP3S-SURE cooperative program for summer 1978.** Alkezweeny, A.J.; Arbuthnot, D.R.; Business, K.M.; Easter, R.C.; Lee, R.N. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

A summary of the Pacific Northwest Laboratory (PNL) aircraft flights, which were part of the Sulfur Regional (SURE) Intensive Experiment, conducted during the summer of 1978, is presented, and some preliminary measurement results are reported. The PNL DC-3 and Cessna 411 research aircraft were used on two consecutive days during the experiment to measure regional-scale pollutant problems over the Ohio Valley.

41595 (PNL—2850(Pt.3), pp 1.7-1.9) **MAP3S precipitation chemistry network.** Dana, M.T.; Drewes, D.R.; Glover, D.W.; Harris, S.D.; Rothert, J.E. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

The Multi-State Atmospheric Power Production Pollutant Studies (MAP3S) network has reached its final number of eight sites. Four of the sites are providing weekly samples in addition to the regular event samples. Early sulfite data indicate significant levels of this species in the wintertime, while sulfate is at a minimum. Sulfate concentrations peak sharply in the summer, but nitrate is more uniform throughout the year. Collectors from the three major North American networks are being compared in event sampling at the Pennsylvania State site.

41596 (PNL—2850(Pt.3), pp 1.9-1.12) **Wet removal of pollutants from winter snowstorms.** Scott, B.C.; Laulainen, N.S.; Thorp, J.M. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

Preliminary aircraft and surface data are presented for the ten storm events sampled in Muskegon, Michigan during the winter of 1977 to 1978. The precipitation chemistry varied widely from site to site and from day to day. Some of the variability can be explained in terms of the primary growth modes of the precipitation particles.

41597 (PNL—2850(Pt.3), pp 1.12-1.15) **Sulfur budget dilemma.** Scott, B.C. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

By incorporating storm convergence into the equations describing pollutant transformation and transport, one can readily compute sufficient airborne sulfate concentrations to account for observed concentrations of sulfate in precipitation. Consideration of incloud conversion of SO_2 to SO_4 is not necessary in order to compute the observed SO_4 washout over the Multistate Atmospheric Power Production Pollutant Studies (MAP3S) region.

41598 (PNL—2850(Pt.3), pp 1.15) **Derivation of wet removal rates for SO_2 gas and SO_4 aerosol.** Scott, B.C.; Dana, M.T. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

If the basic continuity equation is considered, the wet removal of pollutants from the atmosphere can be expressed as the vertical-flux divergence of the pollutant containing precipitation particles. Further, wet removal from a surface boundary-layer can be explicitly stated in terms of a wet-pollutant flux at the surface, provided the layer chosen is thick enough to prevent a pollutant from being carried into the layer from above by precipitation particles. The analysis presented here, which is based upon the time required to grow collector particles to precipitation sizes by accretion of cloud droplets, suggests that the appropriate layer thickness is typically 1200 m or less. Sulfate removal is computed by assuming that the subcloud-sulfate aerosol acts as a cloud-condensation nuclei and is removed by the accretion process. Sulfur dioxide removal is modeled as if it occurred by accretion of droplets by falling snowflakes, or as if it were an equilibrium process for falling water drops. Sulfate wet-removal rates are predicted to be 0 (40% h^{-1}), while SO_2 removal rates are predicted to be 0 (2% h^{-1}).

41599 (PNL—2850(Pt.3), pp 1.17-1.19) **Use of ion chromatography for trace analysis of MAP3S precipitation samples.** Rothert, J.E. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

Ion chromatography is ideally suited for trace analysis of precipitation samples, because several ionic species at various concentrations can be analyzed simultaneously with little or no sample preparation. In the rain samples found in the rural, eastern United States, several species can be easily analyzed; however for trace analysis work, seven species (SO_4^{2-}, NO_3^-, Cl^-, PO_4^{3-}, K^+, NH_4^+, and Na^+) are all that are easily separated, using the anion and cation columns.

41600 (PNL—2850(Pt.3), pp 1.19-1.20) **Preservation of nitrite ion in solution.** Dana, M.T. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

Moderate concentrations of nitrite ion, when added to Multi-State Atmospheric Power Production Pollutant Studies (MAP3S) precipitation samples and distilled-deionized water, decay through oxidation to nitrate very slowly when stored at room or refrigerator temperatures. The decay halftimes range from 44 to hundreds of days under these conditions, but if frozen and rethawed, the concentrations decline very rapidly. Differences in decay rates for precipitation samples may be related to pH or initial nitrate concentration. The method of thawing and number of thaws strongly affect decay rates for frozen samples.

41601 (PNL—2850(Pt.3), pp 1.21-1.23) **Analytical procedure for determining C_2 to C_6 hydrocarbons in ambient air.** Lee, R.N. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

A procedure is described for determining light hydrocarbons in ambient air. This method is being used to examine samples collected in Tedlar bags during flights through urban plumes.

41602 (PNL—2850(Pt.3), pp 1.25) **Airborne ammonia measurements in the Great Lakes Region.** Lee, R.N. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

An impregnated filter method has been employed to determine ammonia concentrations during aircraft sampling missions in the western portion of the Multi-State Atmospheric Power Production Pollutant Studies (MAP3S) region. Observed ammonia concentrations are less than those generally reported for surface sites in rural areas.

41603 (PNL—2850(Pt.3), pp 1.26-1.27) **Modifications to MAP3S regional modeling procedures for comparisons of observed and predicted pollutant concentrations.** McNaughton, D.J. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

New opportunities for regional model comparisons of observed and predicted pollutant concentrations are arising as a result of data collection by Multi-State Atmospheric Power Production Pollutant Studies (MAP3S) Precipitation Chemistry Network and the Sulfate Regional Experiment (SURE). Data, available and comparable between observations and model calculations, are ambient concentrations of sulfur dioxide and sulfates and precipitation acidity for 24-hr and monthly periods. Complete examination of data has required that physical models and model input and output be modified to produce comparable results with observed data.

41604 (PNL—2850(Pt.3), pp 1.27-1.29) **MAP3S modeling development: annual progress.** Powell, D.C. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

The Multi-State Atmospheric Power Production Pollutant Study (MAP3S) modeling capability at Pacific Northwest Laboratory (PNL) now includes the puff model previously reported, a linear plume segment model and a nonlinear plume segment model. The predictions of the puff model are valid only for long-term assessments. The linear plume segment model is adaptable for either short- or long-term calculations. The nonlinear model is intended only for short epidodes including precipitation events.

41605 (PNL—2850(Pt.3), pp 1.30-1.32) **Case study of elevated layers of high sulfate concentration.** McNaughton, D.J.; Orgill, M.M. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

During studies in August 1976 that were part of the Multi-State Atmospheric Power Production Pollutant Study (MAP3S), Alkezweeny et al., (1977) noted that in the Milwaukee urban plume, layers of relatively high sulfate concentrations occurred at high

altitudes with respect to the boundary layer. This paper represents a progress report on studies undertaken to investigate possible causes for a bimodel vertical profile of sulfate concentrations. Data presented by Alkezweeny et al., (1977) serve as a basis for this study. Data from August 23, 1976, and August 24, 1978, indicate concentrations relatively high in sulfate, at 1000 and 6000 ft, respectively, with lower concentrations at lower altitudes. Concentrations of trace metals also indicate no peaks in the vertical concentration profiles above the surface. Initial studies of the high, elevated sulfate concentrations have centered on the August 23 measurements taken over southeast Wisconsin using synoptic data from the national weather service, emissions data from the national emissions data bank system (EPA), air quality data from the national air surveillance network (EPA), and satellite photographs from the EROS Data Center (U.S.G.S.).

41606 (PNL—2850(Pt.3), pp 1.36-1.38) **Dry deposition of atmospheric ozone.** Droppo, J.G.; Doran, J.C. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

The dry removal processes of pollutants associated with emissions from fossil-fuel-fired power plants were studied in field tests. Results of ozone dry deposition tests using both an eddy flux method and a profile method are given. These data are needed as input for modeling long-range transport of atmospheric pollutants.

41607 (PNL—2850(Pt.3), pp 1.38-1.39) **Profile measurements of aerosol deposition.** Doran, J.C.; Droppo, J.G. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

A field test program, which assesses the accuracy of the gradient profile method of determining deposition velocities, is described.

41608 (PNL—2850(Pt.3), pp 1.40-1.41) **Simple correction to the source-depletion model.** Horst, T.W. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

A simple correction, based on gradient-transfer theory, is proposed to correct the source-depletion, diffusion-deposition model for the deposition-caused vertical contaminant profile. The resulting predictions compare very well with those of the surface depletion model.

41609 (PNL—2850(Pt.3), pp 1.45-1.46) **Spectroscopic technique for measuring atmospheric CO_2.** Stokes, G.M.; Stokes, R.A. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

As part of a continuing effort to identify areas in which astronomical techniques and data may be profitably applied to atmospheric problems, both new and archival solar spectra have been collected to prepare for an analysis of their use for studying the changes of the atmospheric CO_2 burden. This analysis has resulted in the initiation of an observing program using the Fourier Transform Spectrometer (FTS) of the McMath Solar Telescope at Kitt Peak National Observatory (KPNO). This program is generating spectra, the quality of which should not only aid the archival CO_2 study but also lead to analyses of other trace gases.

41610 (PNL—2850(Pt.3), pp 2.1-2.2) **A review: deposition and resuspension processes.** Sehmel, G.A. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

A review chapter was written on deposition and resuspension processes for the forthcoming Department of Energy publication, Atmospheric Sciences and Power Production, edited by D. Randerson. The chapter includes eleven tables and thirteen figures summarizing data from 241 references. The conclusions of that review chapter are given.

41611 (PNL—2850(Pt.3), pp 2.2-2.3) **Inert tracer wind resuspension as a function of wind speed, atmospheric stability, and initial tracer particle size.** Sehmel, G.A.; Lloyd, F.D. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

Wind-caused resuspension rates are being determined in three different, long-term, inert-tracer field experiments. Chemical results were recently received from an accumulated backlog of air filter samples. Resuspension rates are yet to be calculated from these data.

41612 (PNL—2850(Pt.3), pp 2.11-2.19) **Technical progress in the alternate fuel cycle program. II.** Davis, W.E.; Eadie, W.J. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

A U.S. scale assessment model developed at Pacific Northwest Laboratory (PNL) was used in an annual assessment for simulated releases from Carlsbad, New Mexico; Morris, Illinois; and Brookhaven, New York in 1975. The estimated concentration of pollutants and deposition were sent to Savannah River to be used to determine the effects of a release from each site.

41613 (PNL—2850(Pt.3), pp 2.21-2.23) **Effect of using time-averaged precipitation for the estimation of wet deposition in a regional scale model.** Davis, W.E. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

A study has been performed to determine why the use of average precipitation causes an increase in wet deposition over the wet deposition caused by the use of hourly precipitation. Results of this study are presented along with additional results from a study using the average precipitation turned on and off for set periods to calculate wet deposition.

41614 (PNL—2850(Pt.3), pp 2.26-2.29) **Cooling tower drift: comprehensive case study.** Laulainen, N.S.; Ulanski, S.L. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

A comprehensive experiment to study drift from mechanical drift cooling towers was conducted during June 1978 at the PG and E Pittsburg Power Plant. The data from this study will be used for validation of drift deposition models. Preliminary results show the effects of tower geometry and orientation with respect to the wind and to single- or two-tower operation. The effect of decreasing relative humidity during a test run can also be seen.

41615 (PNL—2850(Pt.3), pp 2.29) **Lagrangian-similarity diffusion-deposition model.** Horst, T.W. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

A Lagrangian-similarity diffusion model has been incorporated into the surface-depletion deposition model. This model predicts vertical concentration profiles far downwind of the source that agree with those of a one-dimensional gradient-transfer model.

41616 (PNL—2850(Pt.3), pp 3.3-3.6) **Aerosol and visibility measurements in mountainous terrain.** Orgill, M.M.; Drewes, D.R.; Garcia, S.R. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

This study is an initial effort to collect information on the relationship between aerosols and visibility in mountainous terrain and the occurrence of air pollutants from fossil-fuel energy sources. Airborne instruments were used as the primary means of obtaining data.

41617 (PNL—2850(Pt.3), pp 3.10-3.11) **Development of a dual-tracer real-time particle dry-deposition measurement technique for simple and complex terrain.** Sehmel, G.A.; Hodgson, W.H.; Campbell, J.A. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

Detectors are being developed and tested for measuring the airborne concentrations of lithium particles and SF_6 gas in real time. The airborne lithium detector will be used for real-time measurements of both particle dry-deposition velocities and resuspension rates. Both the lithium and SF_6 detectors will be used for measuring dry deposition in field experiments.

41618 (PNL—2850(Pt.3), pp 3.12-3.15) **Particle dry-deposition experiment using ambient airborne soil.** Sehmel, G.A. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

Airborne solid concentrations were measured simultaneously at sampling towers upwind and 305-m downwind of a site. When the wind speed and wind direction were identical at each site, isokinetic air samplers on the sampling towers were automatically activated. The fraction of the airborne solid plume remaining after the 305-m fetch ranged from 0.53 to 1.07.

41619 (PNL—2850(Pt.5)) **Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 5. Environmental assessment, control, health and safety.** Bair, W.J. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Feb 1979. Contract EY-76-C-06-1830. 146p. Dep. NTIS, PC A07/MF A01.

The report is in four sections, corresponding to the program elements: technology impacts, environmental control engineering, operational and environmental compliance and human health studies. Each section was abstracted and indexed separately. (JGB)

41620 (PNL—2850(Pt.5), pp 1.0-1.12) **Technology impacts.** Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 5. Environmental assessment, control, health and safety.

Work in Technology Assessment focused on impacts of increased use of coal, enhanced recovery of oil, oil shale conversion to oil, and changes in radiation standards. It also provided major inputs to formulation of plans for developing several technologies in environmentally acceptable ways and to the evaluation of the environmental feasibility of commercialized application of these technologies. Work conducted in the Environmental Impacts area included cooperative interlaboratory efforts to improve information transfer and shared use of computerized models. These efforts were designed to facilitate cooperative research programs carried on in two or more national laboratories at the same time. In addition to these efforts, a research project was undertaken to compare health risks associated with various energy technologies. Studies in Regional Assessment during FY 1978 focused largely on aspects of water resource use in the Pacific Northwest - Alaska, Washington, Oregon, and Idaho. Some efforts were also devoted to the development of social impact assessment methodologies. Finally, a Data Book was created to present information essential to regional analyses of energy-environmental problems and opportunities. (JGB)

41621 (PNL—2850(Pt.5), pp 3.0-3.9) **Operational and environmental compliance.** Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 5. Environmental assessment, control, health and safety.

A study has been completed on 100 violations of criticality safety specifications that were reported over a ten-year period in the operations of a fuels reprocessing plant. Based on the limited data avaiable, and the underlying assumptions made which affect accident probability, accidents might be expected to occur at a maximum rate of one during each 244 years of plant operation ranging down to a minimum rate of one in every 3000 years. Some general suggestions for improvement were formulated based on the cases studied. Although details may differ, the general method of analysis and the fault-tree logic should prove applicable to other plants as well. In other studies phase two of a three-phase project, planned to assist the nuclear industry in ensuring that radiation doses to personnel shall be maintained as low as practicable (ALAP), technically and economically, focused on the publication of a summary of ALAP efforts at DOE facilities. Based on the results of this report, a first draft of an ALAP manual was completed. A revised working paper of A Guide for Effluent Monitoring at DOE Installations was assembled for sponsor review. The new draft incorporates revisions necessitated by recent legislation, as well as basic discrimination levels for measurement of pollutants in airborne and liquid effluents. Environmental, safety and health (ES and H) standards are being identified and evaluated for their potential application to geothermal energy development. For this evaluation, the ES and H problem areas were subdivided into 14 topics: airborne emissions, liquid waste disposal and water pollution, blowouts/hot water and steam releases, subsidence and induced seismicity, noise, heat stress, sampling and analyses, falling hazards, electrical hazards, heavy equipment operations, soil effects and land-use planning, fire hazards, construction, and hazardous substances. Drafts of seven of these reports are currently being reviewed.

41622 (UCID—18008) **Dispersion model comparisons.** Bowman, B.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Dec 1978. Contract W-7405-ENG-48. 11p. Dep. NTIS, PC A02/MF A01.

Proper modeling of the dispersion process following an LNG spill is critical to hazards evaluation and to the selection of terminal sites and shipping lanes. Predictions of the vapor generation and dispersion determine the downwind, lateral and vertical extent of flammable portions of the hydrocarbon/air mixture and provide initial conditions for deflagration or detonation calculations. These are used to estimate the damage potential of a flammable cloud which might result from a liquid spill. This report contains a status report on the modeling effort at Lawrence Livermore Laboratory and some comparisons of different models used to predict dispersion. Two types of models are considered here. The first is a version of one originally proposed by Germeles and Drake; and the second type is in the form of two finite difference codes, MINT and TDC, which solve the time dependent, compressible, conservation equations with turbulence. Results of these models are compared in terms of the predicted maximum distance to the lower flammability limit as a function of liquid spill volume. Characteristic vertical profiles of the models are also compared for a particular spill size. The major deficiency in all models to date is the unavailability of experimental data at several spill volumes with which to compare predictions.

41623 (UCID—18159) **Treatment of initial and boundary conditions in the application of air quality models.** Duewer, W.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Apr 1979. Contract W-7405-ENG-48. 19p. Dep. NTIS, PC A02/MF A01.

Initial and boundary concentrations can have an influence on model computed results for suburban and downwind areas that approaches the importance of emissions, and can have a significant influence on calculations of secondary pollutants even in central urban areas. Moreover, this is true even when the initial and boundary concentrations are of the order of 1-100 ppB. In most applications, there are almost no data available that are really useful in guiding the choice of boundary conditions, and data obtained with normal air quality modeling instruments are so imprecise that they are more likely to be misleading than useful. Although most current model applications use lower background values than were used even two or three years ago, currently used concentrations are not low enough to be a negligible factor in model calculations. Moreover, except for carbon monoxide, there is little reason to believe that even the lower concentrations used in model applications are as low as those representative of a remote tropospheric air mass. Conversely, there is little reason to believe that the air 10-100 km from a representative urban center should be very close to remote tropospheric air in its composition. Thus, the specification of initial and boundary conditions remains a major problem in the verification and application of air quality models, and all proposed solutions to the problem are of an essentially ad hoc nature. Moreover, existing data collection efforts seem unlikely to significantly improve matters.

41624 **Land's response to more carbon dioxide.** Lemon, E. pp 97-130 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

With a continued increase of fossil fuel carbon dioxide (CO_2) in the atmosphere there is cause for concern about future consequent climate change. Records indicate that about half the CO_2 input remains in the atmosphere and the other half is absorbed by the land and sea. No one knows the proportions or for sure the mechanisms of fixation. On the land the initial CO_2 fixation is by photosynthesis in plants. Short term experiments indicate that photosynthesis is speeded up by more atmospheric CO_2. However, other plant processes and environmental stress may negate this initial response. The life cycle of individual plants and whole forest ecosystems could be shortened too, so that net carbon accululation in the end is little changed. A small change in net photosynthesis of the living biomass of the land might be quite significant however. This would depend upon the size and stability of both living and dead carbon pools. Man's influence on both is a recognized possibility yet both kind and magnitude are unknown. For example, forest cutting might be balanced by regrowth or managed agricultural production. Also soil humus losses from forest cutting or prairie plowing might be balanced by high technology agriculture where plant residues increase soil humus. Eutrophication of lakes and estuaries due to increased nutrient cycling also adds carbon to the detritus pool.

41625 **Global carbon dioxide production from fossil fuels and cement, A.D. 1950 to A.D. 2000.** Rotty, R.M. (Inst. for Energy Analysis, Oak Ridge, TN). pp 167-181 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

Industrial production of carbon dioxide has been increasing at the exponential rate of 4.3 percent almost continuously since 1860. Based on latest revised fuel use and cement manufacture data from the United Nation's Statistical Office, CO_2 production is calculated for each year, 1950 through 1974. The 1974 value is nearly 18 x 10^9 metric tons of CO_2/year (5 x 10^9 metric tons C), about 2 percent of which is a result of cement manufacture. Three scenarios for future energy demand and cement manufacture are developed and used to extrapolate the industrial carbon dioxide production to the year A.D. 2000. The selected scenarios suggest that annual CO_2 production will grow to a value between 30 x 10^9 and 53 x 10^9 metric tons by A.D. 2000, with a most probable value equivalent to 6 ppm of the atmosphere equivalent ($\sim$ 46.5 10^9 metric tons) at that time.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 40451, 40898, 40899, 41590, 41735, 41771, 41772

41626 (ANL—79-24) **Environmental monitoring at Argonne National Laboratory. Annual report for 1978.** Golchert, N.W.; Duffy, T.L.; Sedlet, J. (Argonne National Lab., IL (USA)). Mar 1979. Contract W-31-109-ENG-38. 96p. Dep. NTIS, PC A05/MF A01.

The results of the environmental monitoring program at Argonne National Laboratory for 1978 are presented and discussed. To evaluate the effect of Argonne operations on the environment, measurements were made for a variety of radionuclides in air, surface water, Argonne effluent water, soil, grass, bottom sediment, and foodstuffs; for a variety of chemical constituents in air, surface water, and Argonne effluent water; and of the environmental penetrating radiation dose. Sample collections and measurements were made at the site boundary and off the Argonne site for comparison purposes. Some on-site measurements wee made to aid in the interpretation of the boundary and off-site data. The results of the program are interpreted in terms of the sources and origin of the radioactive and chemical substances (natural, fallout, Argonne, and other) and are compared with applicable environmental quality standards. The potential radiation dose to off-site population groups is also estimated.

41627 (DP—1489) **Savannah River Laboratory environmental transport and effects research. Annual report, 1977.** Crawford, T.V. (comp.). (Savannah River Ecology Lab., Aiken, SC (USA)). Oct 1978. Contract EY-76-C-09-0001. 251p. Dep. NTIS, PC A12/MF A01.

Separate abstracts were prepared for the 50 papers of the report. (HLW)

41628 (DP—1489, pp 21-24) **Source-term study of plutonium-bearing particulates in a nuclear fuel reprocessing plant.** Sanders, S.M. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The most abundant elements in average crustal rock (and soil) are O, Si, Al, Fe, Ca, Na, K, Mg, and Ti. With the exception of oxygen, which was below the detection limit for electron microprobe analyses, these elements were also found in most of the SRP inorganic particles and analyzed. This finding supports the hypothesis that most SRP plutonium-bearing particles are airborne crustal attached. Plutonium could be detected by electron microprobe analysis in only one of the 299 particles selected for analysis, even though fission fragment tracks were found in all 299 particles. Twenty of the particles (7%) were organic, and nine particles (3%) were metallic, viz., iron, chromium, and nickel. The concentration of plutonium-bearing particles in the exhaust decreased with distance from the sources, i.e., as the exhaust stream approached the stacks.

41629 (DP—1489, pp 159-163) **Verification of two simple meteorological models at large travel distances using ten-hour ^{85}Kr measurements.** Pendergast, M.M. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

This report evaluates the wind-rose model and a trajectory model for calculating air concentrations averaged over 10 hours at distances greater than 100 km. Ten-hour averaged ^{85}Kr air concentrations from 13 sites located withing 143 km of the Savannah River Plant (SRP) were used to evaluate two simple models: a wind-rose model, and a trajectory model. The wind-rose model has previously been shown to estimate annual average concentrations to within a factor of four for travel distances of about 100 km. When ^{85}Kr concentrations were observed (80 cases), the wind-rose model predicted above background for only 36 percent of the cases, while the trajectory model predicted above background for 56 percent of the cases. The wind-rose model tended to overpredict air concentration by a factor of 4 while the trajectory model tended to underpredict by a factor of 3 for those occasions where observations and calculations were above background.

41630 (DP—1489, pp 165-169) **Release rates of ^{85}Kr from the Savannah River Plant.** Pendergast, M.M. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The methods and models for determining the hourly release rate of ^{85}Kr from SRP are described. In general, the hourly release rates are accurate to within 20 percent. For average times on the order of 12 hours, the error approaches the accuracy of the total release which is about 5 percent.

41631 (DP—1489, pp 197-198) **Status of Weather Information and Display (WIND) system.** Mueller, R.A.; Kern, C.D. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The Environmental Transport Division (ETD) conducts an extensive program of research on atmosphric transport and dispersion. At the same time, ETD personnel provide improvements to the emergency meteorological response to accidental releases into the atmosphere. Support of this program requires acquisition and archiving of current meteorological data on a regional basis both near the Savannah River Plant (SRP) and throughout the southeastern United States. The Weather Information and Display (WIND) minicomputer system enables scientists to have at their disposal these archived data which provide input to a number of research activities. The WIND system contains programs which calculate transport and dispersion rapidly and display the results in tabular and graphic form. These programs improve the basis for management decisions during an accidental release of pollutants to the atmosphere.

41632 (DP—1489, pp 199-204) **Calculation of three-dimensional dispersion in a tornadic thunderstorm cell.** Pepper, D.W. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The probability of a tornado striking a nuclear facility is remote (however, it is not zero). In May 1976, two tornadoes struck the Savannah River Plant (SRP) on the same day; one touched down in the Central Shops area and lifted at F Area. In June 1976, a large tornado struck one of the nuclear reactors at Argonne National Laboratory (fortunately causing only minor damage). Thus, it is necessary to be able to estimate the dispersion of radioactive particulates released in the event a nuclear facility would be breached. This study is a continuation of the study initially begun by Pepper. The original analytical model has been supplanted by a three-dimensional numerical model, allowing more versatility for incorporating variable meteorological parameters.

41633 (DP—1489, pp 217-220) **JEREMIAH atmospheric transport and dose computational system.** Buckner, M.R. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

A modular environmental transport and dose computational system (JEREMIAH) has been developed to provide assessment of routine pollutant releases and emergency response capability for accidental pollutant releases. The JEREMIAH system provides an integrated structure for the assessment of both routine and accidental radiological releases and allows the use of the most current meteorological data. Synoptic data are also available for use in the assessment of routine releases. The JEREMIAH system uses the modular programming interfaces and data management facilities provided by the JOSHUA operating system. The JEREMIAH system is primarily designed to handle pollutant releases from the Savannah River Plant (SRP); however, other nuclear facilities within the southeastern United States are included in the grid networks provided within JEREMIAH.

41634 (DP—1489, pp 239-246) **Interlaboratory model comparisons of atmospheric concentrations with and without deposition.** Kern, C.D.; Cooper, R.E. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

To calculate the dose to the regional and U.S. populations, the pollutant concentration both with and without deposition and the amount of material deposited on the ground and watersheds around such a facility must be known. The following report (Article 50) of this document contains some initial estimates of population exposure from atmospheric effluents. The expertise of laboratories supported by U.S. Department of Energy funds ensures that the latest methods and data are available. Lawrence Livermore Laboratory (LLL) performed regional calculations (out to distances of the order of 200 km from a hypothetical fuel reprocessing plant). The Air Resources Laboratory (ARL) of the National Oceanic and Atmospheric Administration (NOAA), and Battelle Pacific Northwest Laboratories (PNL) performed U.S. scale calculations, and ARL also did the global calculations. Data from a winter and summer period were used to make comparisons of calculations by LLL, ARL, and PNL to determine which model should be used for the final calculations and to determine if a 200-km square area centered on the site would be large enough for dose calculations via the water and food pathways.

41635 (DP—1489, pp 247-255) **Population exposure estimates from atmospheric effluents from a model fuel reprocessing plant.** Cooper, R.E. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The SRL effort to estimate population exposure is confined to dose-to-man contributions resulting from immersion in contaminated air and from external beta and gamma dose caused by exposure to contaminated ground. Population exposures resulting from immersion in contaminated air traditionally have been given more attention. A primary objective of this study is to develop a technique to provide an adequate estimation of population dose resulting from ground depositions, and to establish the relative importance of the contributing factors. This study shows that the cumulative population gamma dose from operating a nuclear reprocessing facility is 264 man-rem over a fifty-year period. When compared with the 8,780,000 man-rem cumulative population gamma exposure from

natural sources (sun, granite, thorium in sand, etc.), the increment from processing facility operations is only about 0.003% of the total.

41636 (DPSPU—78-302) **Environmental monitoring at the Savannah River Plant. Annual report, 1977.** Ashley, C.; Zeigler, C.C. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Plant). Dec 1978. Contract EY-76-C-09-0001. 155p. Dep. NTIS, PC A08/MF A01.

Progress is reported on radioactive monitoring of the atmosphere, drinking water, the Savannah River, ground water, soil, vegetation, food, milk, terrestrial animals, aquatic animals, and special surveys. Results of nonradioactive monitoring are reported for the atmosphere, the Savannah River, pesticides in rivers and streams, and special surveys. Appendices are included on data analysis, quality control, and sensitivity and standard deviation of laboratory analyses. (HLW)

41637 (EGG—1183-1700) **Aerial radiological survey of the Weldon Spring Chemical Plant (St. Charles, Missouri). Date of survey: 11—14 May 1976.** Jobst, J.E. (EG and G, Inc., Las Vegas, NV (USA)). Jan 1977. Contract EY-76-C-08-1183. 39p. Dep. NTIS, PC A03/MF A01.

An aerial radiological survey was conducted over the Weldon Spring Chemical Plant, which is in St. Charles County, thirty miles from St. Louis, Missouri. The survey was performed in May 1976 using sodium iodide detectors mounted in a helicopter. Gamma gross count and thallium radiation isopleths were superposed on an aerial photograph of the Site. Several concentrations of uraium and thorium waste were located. All contaminants were on the Site or within 200m of the fence line. The survey was sponsored by the U.S. Department of the Army, authorized by the U.S. Energy Research and Development Administration, and conducted by EG and G, Incorporated of Las Vegas, Nevada.

41638 (LA—7800-ENV) **Environmental surveillance at Los Alamos.** (Los Alamos Scientific Lab., NM (USA)). Apr 1979. Contract W-7405-ENG-48. 119p. Dep. NTIS, PC A06/MF A01.

This report documents the environmental surveillance program conducted by the Los Alamos Scientific Laboratory (LASL) in 1978. Routine monitoring for radiation and radioactive or chemical substances is conducted on the Laboratory site and in the surrounding region to determine compliance with appropriate standards and permit early identification of possible undesirable trends. Results and interpretation of the data for 1978 on penetrating radiation, chemical and radiochemical quality of ambient air, surface and groundwater, municipal water supply, soils and sediments, food, and airborne and liquid effluents are included. Comparisons with appropriate standards and regulations or with background levels from natural or other non-LASL sources provide a basis for concluding that environmental effects attributable to LASL operations are minor and cannot be considered likely to result in any hazard to the population of the area. Results of several special studies provide documentation of some unique environmental conditions in the LASL environs.

41639 (PNL—2850(Pt.3), pp 2.4-2.7) **Airborne plutonium and americium concentrations measured from the top of Rattlesnake Mountain.** Sehmel, G.A. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

Airborne plutonium-239+240 and americium-241 blowing from offsite was measured in an initial experiment at the top of Rattlesnake Mountain. Average airborne concentration measured was similar to fallout concentrations. Airborne plutonium concentrations were independent of wind speed for seven wind speed increments between 0.5 and 31 m/sec. In contrast the airborne americium concentration was a minimum at a wind speed of approximately 7 m/sec. Similarly, the airborne solids concentration in $\mu g/m^3$ was a minimum at an intermediate wind speed increment of 7 to 11 m/sec.

41640 (PNL—2850(Pt.3), pp 2.7-2.11) **Plutonium resuspension.** Sehmel, G.A. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

A second experiment near the Prosser barricade in the Hanford area confirmed that airborne plutonium was beng blown in from offsite by southwesterly winds.

41641 (PNL—2850(Pt.3), pp 2.24-2.26) **Redistribution of a layer of HTO by rainfall.** Dana, M.T.; Davis, W.E. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

A uniform layer of HTO, when encountering a warm or cold front with rainfall, may be simultaneously lifted by frontal air motions over the front and lowered by reversible HTO scavenging. Illustrative calculations show that under typical conditions a layer of HTO bordering the ground may move through a front without rising. The attendant rainfall in this case causes a decay in the concentration which may be significant over the time of frontal pass through.

41642 (PNL—2850(Pt.3), pp 2.30-2.32) **Radioactive fallout from Chinese nuclear weapons test of March 15, 1978.** Thomas, C.W. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

Pacific Northwest Laboratory (PNL) has measured the radionuclide concentration of short-lived debris from a radioactive cloud, produced by a nuclear weapons test conducted by the People's Republic of China on March 15, 1978. Analysis with a 40 cfm Sierra impactor showed that a large portion of the radioactivity was associated with relatively large particles. Surface air samples showed significant concentrations of ^{134}Sb. Samples of rain water from New York State showed that radioactivity arrived on the east coast at about the same time as peak debris levels were observed on the west coast. Highest concentrations of ^{131}I occurred along the Washington State—Canadian border.

41643 (SLAC—218) **Annual environmental monitoring report, January—December 1978.** (Stanford Linear Accelerator Center, CA (USA)). Apr 1979. Contract EY-76-C-03-0515. 28p. Dep. NTIS, PC A03/MF A01.

Environmental monitoring results continue to demonstrate that, except for penetrating radiation, environmental radiological impact due to SLAC operation is not distinguishable from natural environmental sources. During 1978, the maximum neutron dose near the site boundary was 6.6 mrem. This represents about 6.6% of the annual dose from natural sources at this elevation, and 1.3% of the technical standard of 500 mrem per person annually. There have been no measurable increases in radioactivity in ground water attributable to SLAC operations since 1966. Because of major new construction, well water samples were not collected and analyzed during 1978. Construction activities have also temporarily placed our sampling stations for the sanitary and storm sewers out of service. They will be re-established as soon as construction activities permit. Airborne radioactivity released from SLAC continues to make only a negligible environmental impact, and results in a site boundary annual dose of less than 0.01 mrem; this represents less than 0.01% of the annual dose from the natural radiation environment, and about 0.002% of the technical standard.

41644 (UCID—18050) **Operators guide: Atmospheric Release Advisory Capability (ARAC) site facility.** Cassaro, E.; Lomonaco, L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jan 1979. Contract W-7405-ENG-48. 43p. Dep. NTIS, PC A03/MF A01.

The Atmospheric Release Advisory Capability (ARAC) is designed to help officials at designated DOE sites and other locations in estimating the effects of atmospheric releases of radionuclides or other hazardous materials by issuing real-time advisories to guide them in their planning. This report outlines the capabilities and sources of ARAC, and in more detail describes an ARAC Site Facility, its operating procedures and interactions with the ARAC Central Facility (ACF) located at LLL.

REGULATIONS

REFER ALSO TO CITATION(S) 40232, 41031, 41100, 41111, 41589

41645 (EPA—600/7-78-058a, pp 9-19) **Clean Air Act Amendments of 1977: new dimensions in air quality management.** Hawkins, D.G. (Environmental Protection Agency, Washington, DC). Mar 1978.

From Symposium on flue gas desulfurization; Hollywood, FL, USA (Nov 1977).

The implications of the 1977 Amendments of the Clean Air Act are discussed with respect to EPA's responsibilities, state responsibilities, compliance and enforcement, regulations and standards (for SO_2), prevention of significant deterioration of air quality, etc. (LTN)

ENVIRONMENTAL SCIENCES,

TERRESTRIAL

BASIC STUDIES

REFER ALSO TO CITATION(S) 40183

41646 (DP—1489, pp 33-35) **Soil water measurements with gamma and neutron probes.** Murphy, C.E.; Dexter, A.H. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The predicted accuracy of the neutron instrument for measuring the volumetric soil water content is about +-1.2 percent as determined by an error analysis. This accuracy was verified indirectly by measuring the water content of the soil in Plot 16 over a three-month period. The soil water content appeared to remain virtually constant over a range of depths (38 to 66 in.); during this period, the water content readings were identical to within +-2.5 percent. Bulk density results were also within +-3 percent. Thus the consistency of the bulk density determinations, as calculated for different dates when the water content differed, is a measure of the performance of both instruments.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 41581, 41588, 41624, 41636, 41638, 41672

41647 (DP—1489, pp 41-43) **Oil biodegradation study.** Watts, J.R. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

Waste lubricants and other organic liquids are a byproduct of most large industrial complexes. These materials are discarded by two methods: ponding (biodegradation) or burning. Both techniques have environmental impacts. Oak Ridge, Tennessee, and Deer Park, Texas, studies found oil biodegradation in soil is acceptable for routine oil disposal. At the Savannah River Plant (SRP), most waste oils are burned in an onsite power plant as a supplemental energy source to coal. However, some organic fluids are not acceptable for burning because of chemical or heavy metal contamination. In July 1975, Savannah River Laboratory (SRL) began investigating oil biodegradation in soil as a method to dispose of nonburnable organic liquids. To be an acceptable method, biodegradation must permit no oil migration to the water table of to surface streams during the degradation process and must allow the restoration of the fertility and appearance of the land to the preapplication level.

41648 (PB—287215) **Virus survival in soils injected with municipal wastewater treatment residuals. Final executive summary.** Sagik, B.P. (Texas Univ., San Antonio (USA). Center for Applied Research and Technology). Jun 1978. 24p. NTIS PC A02/MF A01.

The primary objective of this program was to determine possible viral contamination of the environment resulting from domestic sludge injection into soils. Specific goals were: (1) determination of virus levels in specific treatment plant sludges; (2) determination of sludge virus levels at the time of injection into soils; (3) concentration from soil and enumeration of viruses at varying periods after sludge injection; (4) quantification of survival of polioviruses, coliphages and fecal coliforms in soil; and (5) studying in the laboratory viral movement through soils. In laboratory studies, it was shown that viruses incorporated in sludge were recovered from soil column percolates at significantly lower levels than were viruses added in effluents (<1% compared to 19-47% recovery with effluent application). These results suggest that sludge-associated viruses may be retained effectively within the sludge-soil matrix.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 40456, 41628, 41636, 41638

41649 (DP—1489, pp 25-28) **Summary of plutonium terrestrial research studies in the vicinity of a nuclear fuel reprocessing plant.** Corey, J.C.; Boni, A.L.; Andriano, D.C.; Pinder, J.F.; McLeod, K.W. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

This paper reports plutonium concentrations of wheat, soybeans, and corn grown (a) on a field adjacent to one of the nuclear reprocessing facilities at the Savannah River Plant (SRP), (b) in a glasshouse, and (c) offsite. The crops on SRP were grown on a field that has been receiving both fallout plutonium and plutonium emitted at low chronic levels from an air exhaust stack since 1955. The crops grown in the glasshouse were raised on soil from the onsite agricultural field. The offsite field has received only fallout plutonium. The crop data indicate that the dose to an individual from ingesting grain grown on the field, although higher than from ingesting grain grown offsite, is still small (the 70-year dose-to-bone from eating 2 X 10^5 g (440 lb) of wheat in a year would be less than one mrem). Crop data from the field and the glasshouse experiment indicate that less than 10% of the total contamination of field-grown crops adjacent to a reprocessing facility was contributed by root uptake, the remainder by deposition on the plant surfaces. The plutonium content of the grain was generally 10 to 100 times less than that of the vegetation, again suggesting that deposition from stack emissions vegetation, again suggesting that deposition from stack emissions on the vegetation increased the plutonium content; whereas the grain, particularly corn and soybeans, was protected by thehusk or pod and contained principally plutonium from the root uptake pathway.

41650 (DP—1489, pp 31-32) **SRP deer hunt data base.** Watts, J.R. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The Savannah River Plant (SRP) site is an ideal habitat for white-tailed deer. The large deer population of more than 6000 animals has resulted in collisions between deer and automobiles. To control this population and thus reduce accidents, deer hunts were begun in 1965. These hunts are organized and supervised by U.S. Forestry Service Personnel. The deer have access to all of the plant site except the fenced operating areas. Access to radioactive liquid effluents and contamination vegetation can result in radioactive body burdens in deer. Prior to 1970, samples of about 20% of the deer shot during the deer hunts were radioassayed. Based on these results and plant effluent information, ^{137}Cs was the radionuclide of interest. A portable instrument was developed to measure ^{137}Cs in deer and, beginning in 1970, all deer have been monitored for their ^{137}Cs concentration before being released to the hunters. All slain deer were released to the hunters immediately after monitoring; no deer were above acceptable safe limits for food.

41651 (DP—1489, pp 37-40) **In-situ measurements of soil-water conductivity.** Murphy, C.E. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

Radionuclides and other environmentally important materials often move in association with water. In terrestrial ecosystems, the storage and movement of water in the soil is of prime importance to the hydrologic cycle of the ecosystem. The soil-water conductivity (the rate at which water moves through the soil) is a necessary input to models of soil-water movement. In situ techniques for measurement of soil-water conductivity have the advantage of averaging soil-water properties over larger areas than most laboratory methods. The in situ techniques also cause minimum disturbance of the soil under investigation. Results of measurements using a period of soil-water drainage after initial wetting indicate that soil-water conductivity and its variation with soil-water content can be determined with reasonable accuracy for the plot where the measurements were made. Further investigations are being carried out to look at variability between plots within a soil type.

SOIL

REFER ALSO TO CITATION(S) 40431, 40438, 40443, 40444, 40452, 40453

41652 (PNL—2741) **Comparative availability of cesium and strontium for plant absorption from amended Rupert surface soil and associated subsoil: influence of growth conditions.** Cataldo, D.A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Mar 1979. Contract EY-76-C-06-1830. 23p. Dep. NTIS, PC A02/MF A01.

Studies were undertaken to determine the plant availability of ^{134}Cs and ^{85}Sr amended to Rupert surface soil and an associated subsoil. Concentration ratios for cheatgrass (Bromus tectorum) and tumbleweed (Salsola kali) grown on ^{134}Cs amended Rupert soil were 0.15 and 0.28, respectively; values for amended subsoils were 0.074 and 0.13, respectively. Rupert surface soil and subsoil amended with ^{85}Sr gave concentration ratios of 15 and 7, respectively, for both tumbleweed and cheatgrass. While pot size (1 vs 4 kg) had a market effect on concentration ratios, values for greenhouses and growth chamber grown plants were generally similar. Aging of both Rupert surface soil and subsoils for 1 to 30 days prior to planting had a pronounced effect on the availability of ^{134}Cs for uptake by plants, but no effect on ^{85}Sr uptake.

TERRESTRIAL ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 41626, 41652

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 41015, 41020, 41029, 41030, 41063, 41078, 41107

REGULATIONS

REFER ALSO TO CITATION(S) 41079

ENVIRONMENTAL SCIENCES, AQUATIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 41774

41653 Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977). 761p. (CONF-760168—). $54.50.

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

The question of whether the CO_2 content of the atmosphere is increasing at a catastrophic rate is a very timely question. Will the increase in the atmospheric CO_2 content affect our climate and environment. This question cannot be answered, however, without first defining the behavior and the history of CO_2 in our total environment. Carbon chemistry of the ocean must be closely related to the balance between the precipitation undersaturated deep waters. This in turn is related to the biosphere, both oceanic and terrestrial, and geological processing occurring in sediments. Apparent fluctuations in this balance, as observed in the sedimentary column, have stimulated efforts to clarify the controlling factors which are operating in the present oceans. As this understanding has improved, it has become appreciated not only how sensitive the dynamic $CaCO_3$ precipitation-dissolution cycle may be to the injection of fossil fuel CO_2 into the oceans, but also how serious the possible consequences of such an injection may be. These problems were addressed by the various papers presented at the meeting. The general structure of the meeting was comprised of three broad categories: the mobilization of CO_2 and resulting injections into the oceans, including the ensuing processes which would occur in the water column; the phenomena which would occur at the sea-sediment interface as a consequence of such injections; and the geological implications created in the sedimentary column. Separate entries were made for the individual papers.

41654 Climate changes and lags in pacific carbonate preservation, sea surface temperature and global ice volume. Moore, T.C. Jr.; Pisias, N.G.; Heath, G.R. pp 145-165 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

Past increases in global ice volume (as indicated by oxygen isotopes) appear to have led increases in carbonate preservation by at least 6000 years in several cores studied from the tropical Pacific Ocean. A comparison of the carbonate-preservation and oxygen-isotope spectra in two core shows maxima in coherence at frequencies close to the Milankovitch periods. At these frequencies the oxygen isotope record tends to lead the carbonate record by about 10,000 years. Cross correlation of the estimated sea surface temperature and the oxygen isotope records in one of the tropical Pacific cores indicates that changes in global ice volume preceded local temperature changes by about 4,000 years. In a core from the North Pacific Ocean, cross correlations of both sea surface temperature estimates and carbonate concentrations with oxygen isotopes show no lead or lag. Thus, two regions of the Pacific basin show marked differences in the fluctuations of carbonate and sea surface temperature relative to ice volume. There is no indication that changes in sea surface temperatures in the regions studied induced changes in ice volume; however, regional differences in the response time of carbonate to climatic change suggest that hydrographic as well as geochemical mechanisms are involved in glacial-interglacial changes in carbonate preservation.

41655 Sedimentation and dissolution of pteropods in the ocean. Berner, R.A. (Yale Univ., New Haven). pp 243-260 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

Analysis of very limited data for the relative abundance of pteropods (aragonite) and planktonic foraminifera (calcite) in pelagic realm. This is quantitatively verified by numerous determinations of the pteropod/planktonic foraminifera ratio in pelagic bottom sediments which have lost little or no $CaCO_3$ by dissolution. When coccoliths (calcite) and size differences are considered it is concluded that about 50% by weight of the $CaCO_3$ sedimenting to the sea floor consists of aragonite. This is a much larger number than previously belived. Because most sea water below the thermocline is undersaturated with respect to aragonite, pteropods dissolve before burial in most pelagic sediments. However, on certain topographic high, pteropods may accumulate to form pteropod ooze. Maximum depths for pteropod ooze are $\sim$ 500 m in the central Pacific Ocean and $\sim$ 2800 m in the Atlantic Ocean. Pteropods are also abundant in the sediments of the Mediterranean and Red Sea. Pteropods dissolve preferentially relative to foraminifera and coccoliths because of the greater solubility of aragonite, compared to calcite. This demonstrates the importance of physical chemistry in controlling the $CaCO_3$ distribution in oceanic sediments. The pteropods dissolve mainly while resting on the ocean bottom and not while settling. Because of the large flux of aragonite to the bottom, and consequently larger input of dissolved $CaCO_3$ to deep water, a $CaCO_3$ mass balance for the oceans can be obtained using the model of Broecker (1971).

41656 ^{13}C variations in marine carbonate sediments as indicators of the CO_2 balance between the atmosphere and oceans. Kroopnick, P.M. (Univ. of Hawaii, Honolulu); Margolis, S.V.; Wong, C.S. pp 295-321 of Fate of fossil fuel CO_2 in the ocean. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

A model is presented to explain the departures from equilibrium of the ocean-atmosphereCO_2—^{13}C system with respect to temperature, latitude and water mass characteristics. Carbon isotope data suggests that invasion and evasion of CO_2 to and from the sea is at least partially controlled by the organic productivity of a water mass. Surface wager δ values are determined by exchange with the atmosphere and by the amount of carbon removed versus that replenished. Deeper water δ ^{13}C values are controlled by the relative rates of upwelling of deep water, by in situ respiration, and by the dissolution of settling particles. The record of δ ^{13}C fluctuation for the last 75 million years in oceanic surface and bottom waters is recorded in the calcareous remains of benthic and planktonic forminifera and in nannofossils. The assumption of equilibrium deposition of carbon isotopes by these organisms is shown to not always be the case. Nevertheless, the trend of δ ^{13}C values derived from these three organisms are parallel for the majority of the Late Cretaceous and Cenozoic, perhaps indicating that they are responding to ocean-wide productivity variations. The exact nature of the processes responsible for δ ^{13}C variations in fossil carbonate sediments, however, is still unknown, but increased understanding of δ ^{13}C variations in the present-day oceans and atmosphere will eventually aid in understanding and interpreting the significance of past fluctuations in the CO_2—^{13}C—$CaCO_3$ system.

41657 Carbonate chemistry of North Atlantic Ocean deep-sea sediment pore water. Morse, J.W. (Univ. of Miami, FL). pp 323-343 of Fate of fossil fuel CO_2 in the ocean. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

The carbonate chemistry of twenty cores taken in the central North Atlantic Ocean has been studied in order to elucidate the processes controlling the diagenesis of calcium carbonate in deepsea sediments. Two major problems make the interpretation of the results uncertain: lack of knowledge of the extent to which reactions take place between the calcium carbonate in the sediment and the pore water during recovery and short-term storage; and the large differences presently reported in values for the equilibrium ion product of calcite. If there is little reaction between the calcium carbonate in the sediment and the pore water during the core recovery and short-term storag, three important conclusions can be drawn from the data presented in this study. Sediments below 3000 meters water depth are more under-ssaturated with respect to calcite than is the overlying water. Very little reaction takes place between the calcium carbonate in these sediments, and the pore waters in the upper meter of sediment, which could be due to rapid coating of the calcium carbonate grains after deposition at the sediment water interface. In sediments above 3000 meters water depth, small amounts of aragonite in the upper few centemeters of sediment exert a strong influence on the carbonate chemistry of the pore waters.

41658 Modelling the influence of bioturbation and other processes on calcium carbonate dissolution at the sea floor. Schink, D.R.; Guinasso, Jr. (Texas A and M Univ., College Station). pp 375-399 of Fate of fossil fuel CO_2 in the ocean. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

Profiles of dissolved and particulate carbonate in abyssal sediments have been calculated and the associated fluxes determined. The fractions of $CaCO_3$ in accumulating sediments were then evaluated. The calculations considered: effect of depth on solubility; rate of dissolution linearly decreasing as saturation approaches; rate of bioturbation; rate of supply of carbonate sediment; input rate of noncalcareous sediment; rate of bioturbation; and impedance of a nonturbulent boundary layer. These calculation indicate that the "carbonate compensation depth" would have a narrow depth range even if the dissolution rate increased only linearly with departure from saturation; that when carbonate accululation is nil, pore waters may still saturate with carbonate ion; that increases in the supply flux of carbonate by a factor of two will deepen the compensation level by more than a kilometer; that bioturbation has much less influence on the carbonate system that it has on interstitial silica; and that bottom currents or turbulence can have very significant influence on the calcium carbonate accululation patterns.

41659 Equilibrium and mechanism of dissolution of Mg-calcites. Wollast, R.; Reinhard-Derie, D. (Univ., Brussels). pp 479-493 of Fate of fossil fuel CO_2 in the ocean. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

The dissolution of Mg-calcite, the most abundant carbonate secreted by marine organisms, is discussed in terms of the thermodynamic implications concerning the dissolution of a solid solution. A method of theoretical interpretation of the experimental results is proposed. It is also shown that the composition of the equilibrium mixture of the final aqueous and solid solution depends on the initial ratio of solid to liquid used in the experiments. The mechanism of the dissolution is further considered on the basis of kinetic data and examination of the initial and final products of the reaction. It is concluded that the experimental study of the dissolution of natural Mg-calcites is much complicated by the fact that marine organisms are generally heterogeneous solid solutions, and that marine organisms are generally heterogeneous solid solutions, and that reprecipitation of a series of new solid solutions on the surface of the initial Mg-calcite lead to a multiphase system which strongly prevents this system from reaching the equilibrium at the time scale used in laboratory experiments. It is thus difficult at this time to precisely quantify the influence of the composition of the Mg-calcite on its dissolution in the marine environmet and further studies are indispensable to a better comprehension of an essential step of the cycle of CO_2 in the ocean.

41660 Dissolution of calcium carbonate in the Sargasso Sea (Northwest Atlantic). Milliman, J.D. (Woods Hole Oceanographic Institution, MA). pp 641-653 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

Results from four dissolution experiments in the Sargasso Sea show that: the lysoclines for aragonite, magnesian calcite and calcite occur at critical levels of undersaturation, about 50 percent in each instances; the fact that the aragonitic compensation depth is shallower than the aragonitic lysocline reflects the high degree of dissolution (and thus, understuration) above the lysocline; shallow zone of dissolution, between 2000 and 2500 m, may be related to concentration of organic matter and its subsequent recycling; dissolution of carbonate particles is not uniform, but rather occurs at points and zones of weakness; and until effective surface areas can be measured, experimental dissolution data cannot be quantified.

41661 Characteristics and genesis of shallow-water and deep-sea limestones. Milliman, D.D. (Woods Hole Oceanographic Institution, MA); Mueller, J. pp 655-672 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

The cements in shallow-water limestones and beachrocks, micritic crusts and non-skeletal carbonates (ooids, grapestone, and cryptocrystalline lumps) display many petrographic and mineralogic similarities and particularly close isotope composition. Genesis of these various shallow-water cements and grains appears to be biologically controlled, but whether by direct biologic precipitation or biologic catalysis is not known; blue-green algae seem a likely agent. In contrast, the cements of many deep-sea limestones appear to have precipitated inorganically. Chalks cement through the reprecipitation of carbonate released by dissolution of more soluble grains. Other deep-sea limestones require igneous activity to facilitate lithification. Particularly interesting are those limestones and lutites occurring in non-depositional areas (plateaus and guyots) and hypersaline basins; isotopic data of these carbonates suggest precipitation from ambient water at or near the sediment-water interface. The apparent lack of inorganic precipitation in shallow tropical waters probably reflects the strong dominance of biologic calcification, particularly by algae. Physiochemical processes can dominate in deeaper aphotic waters, but only in those few environments which are supersaturated with respect to calcium carbonate.

41662 Textural variations of calcareous coarse fractions in the Panama Basin (Eastern Equatorial Pacific Ocean). Thiede, J. (Oregon State Univ., Corvallis). pp 673-692 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

Panama Basin sediment surface coarse fractions are doninantly composed of planktonic foraminiferal remains. Textural studies of these coarse fractions by means of a large diameter settling tube system reveal characteristic grain size spectra with important modes at 2.0-2.25 phi, 2.3-2.45 /jo. 2.5-2.75 phi, 3.0-3.3 phi, and 3.4-3.75 phi. The coarser modes consist of large Globoquadrina dutertrei and Globorotalia menardii shells, the finer ones of small planktonic foraminiferal species and of shell fragments of the larger species. Analysis of samples from the Carnegie Gap provide sufficient information such that the extent of the high energy environment close to the sill depth can be mapped; the textural analyses also seem to indicate south and northward flowing components of the bottom currents which transport particle assemblages with distinct textural characteristics. The samples bear evidence for large scale removal of calcareous fines from the crests of structural highs; the fines are then dumped on the flanks of these elevations.

41663 Chalk formation: early diagenesis. Wise, S.W. Jr. (Florida State Univ., Tallahassee). pp 717-739 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

Induration of chalk layers during the early diagenesis of deep sea carbonate oozes is effected primarily by processes of cementation superimposed on the normal depth dependent effects of gravitational capaction. Units having a high "diagenetic potential" due to the deposition of greater amounts of metastable particles are likely to become lithified earliest so that the induration of the sediment layers does not proceed uniformly. Calcium carbonate cement is derived from the in situ dissolution of metastable particles and is precipitated on more stable particles as low magnesium calcite overgrowths. This process may be inhibited by the presence of non-carbonate impurities such as clay minerals, volcanic ash or siliceous microfossils, but where effective, it allows lithification to proceed in a manner which conserves calcium carbonate within the sediment pile, thus allowing little carbonate or CO_2 to be recycled into the hydrosphere or atmosphere during diagenesis.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 40309, 40310, 40311, 40312, 40313, 40314, 40323, 40813, 41580, 41583, 41584, 41588, 41589, 41619, 41621, 41625, 41626, 41627, 41636, 41638, 41647, 41697, 41730, 41757, 41762, 41774

41664 (DP—1489, pp 87-92) **H_2S transport data for an aquatic system.** Kiser, D.L. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

Upsets in the operation of the wastewater strippers in the heavy water extraction facility of the 400 Area at the Savannah River Plant (SRP) have released significant amounts of dissolved hydrogen sulfide to Beaver Dam Creek. Concern exists about the impact of these releases to the environs downstream of the 400 Area. The Beaver Dam Creek model of stream transport processed by the computer code LODIPS (LOngitudinal DIspersion of a Pollutant in a Natural Stream) grossly overpredicted the downstream concentrations based on some known facts about the releases. A literature survey revealed volatilization and oxidation as the significant hydrogen sulfide loss mechanisms. LODIPS has no option to account for some sink-source effects in a stream. Coefficients of volatilization and oxidation must be developed to use the option. Some field data are necessary to determine the coefficients.

41665 (DP—1489, pp 105-109) **Genetic variability of E. coli in southeastern reservoirs.** Kasweck, K.L.; Fliermans, C.B. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The data indicate that there is an emergence of a lactose negative population in chambers containing a predominately lactose positive population when that population is subjected to conditions peculiar to the heated effluent from a nuclear production reactor. The effect is more than a temperature phenomenon, because E. coli colonies placed in chambers subjected to similar temperatures in other natural systems did not vary in their lactose utilization characteristics. Additionally, chambers placed in deeper cooler waters varied in their lactose characteristic but to a slower degree than the overlying epilimnion waters. Regardless of the cause of the lactose change, the result is that standard methods do not easily detect or quantitate E. coli in Par Pond waters. The assessment of water quality based on fecal coliform measurements in lakes similar to Par Pond would result in data that would indicate that the water quality of such lakes is better than it really is.

41666 (DP—1489, pp 233-235) **Sea surface stability parameters.** Weber, A.H.; Suich, J.E. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

A number of studies dealing with climatology of the Northwest Atlantic Ocean have been published in the last ten years. These published studies have dealt with directly measured meteorological parameters, e.g., wind speed, temperature, etc. This information has been useful because of the increased focus on the near coastal zone where man's activities are increasing in magnitude and scope, e.g., offshore power plants, petroleum production, and the subsequent environmental impacts of these activities. Atmospheric transport of passive or nonpassive material is significantly influenced by the turbulence structure of the atmosphere in the region of the atmosphere-ocean interface. This research entails identification of the suitability of standard atmospheric stability parameters which can be used to determine turbulence structure; the calculation of these parameters for the near-shore and continental shelf regions of the U.S. east coast from Cape Hatteras to Miami, Florida; and the preparation of a climatology of these parameters. In addition, a climatology for average surface stress for the same geographical region is being prepared.

41667 (EPRI-EA—936) **Aquatic microcosms for assessment of effluent effects. Final report.** Harte, J.; Levy, D.; Lapan, E.; Jassby, A.; Dudzik, M.; Rees, J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1978. Contract W-7405-ENG-48. 98p. Dep. NTIS, PC A05/MF A01.

Laboratory freshwater lake microcosms are studied with respect to their usefulness in providing a tool for environmental impact assessment. The microcosm system studied consists of a diverse assemblage of phytoplankton, zooplankton, and microbes in four sets of sextuplet 50-liter tanks initiated under four different nutrient level conditions. Three four-month studies were carried out, each with a different pollutant expected to be found in significant concentration in the aqueous effluent from coal gasification operations. These studies have led to: identification of those biological and chemical parameters most useful for evaluating the responses of microcosms to chemical pollutants; characterization of the difficulties in obtaining replicate microcosms that approximately simulate natural systems; a test of the usefulness of microcosms in evaluating hypothetical stability indicators; evaluation of the relative usefulness of the bloom and the quiescent stages of microcosm development for impact assessment studies; and a specific research plan for determining optimum procedures for microcosm design, initiation, and operation.

41668 (SAND—79-0182, pp 27-36) **Development of pathogen risk assessment models for the evaluation of sludge management alternatives.** Yeager, J.G. (The BDM Corp., Albuquerque, NM); Sheridan, R.E.; Ward, R.L. Feb 1979.

From Sandia irradiator for dried sewage solids seminar and dedication; Albuquerque, NM, USA (18 Oct 1978).

The constraints imposed on sewage treatment and disposal by clean air and water legislation make it clear that, in the near future, there will be increasing amounts of sewage sludge and fewer alternatives for its disposal. Additionally, this legislation has encouraged the use of waste management procedures which emphasize the recycling of waste materials. Decisions regarding optimal methods of sludge handling will primarily be controlled by economic considerations including the intrinsic value of the sludge, the cost of transporting sludge and sludge products, and the degree of treatment necessary to make the sludge suitable for particular applications. One principal reason to treat sludge is to inactivate pathogens. However, the actual health risks posed by pathogenic species that result from different methods of sludge utilization and how these risks are affected by different treatment processes are poorly understood. Therefore, computerized models are being developed to describe pathogen transport through environmental pathways and to help predict the risk of certain sludge utilization practices.

41669 Impact of anoxia on Mn fluxes in the Chesapeake Bay. Eaton, A. (Johns Hopkins Univ., Baltimore, MD). *Geochim. Cosmochim. Acta;* 43: No. 3, 429-432(Mar 1979).

Release of Mn into bottom waters of the Chesapeake Bay occurs in massive quantities during summertime periods of anoxia. The measured flux is much greater than can be accounted for by diffusion from pore waters under normal concentration gradients and is enhanced by dissolution of Mn-oxides under low Eh conditions. Extrapolating flux rates to the area of the Bay which goes anoxic during the summer indicates that this internal cycling accounts for four times as much Mn entering Bay waters as the total annual input (soluble and suspended) from the Susquehanna River.

41670 Surface wind and drift of surface-residing materials on Westernport Bay. Spillane, K.T.; Robinson, R.M.; Hess, G.D. Melbourne, Australia; Commonwealth Scientific and Industrial Research Organization (1978). 55p.

An examination of the spatial correlation of winds, reported at 10 stations over periods up to two years, shows that within the accuracy of measurement of representative wind, a single station may be taken as representative of the Westernport Bay region. Observations of drift—wind factors within the Bay indicate that u/sub s/ = 0.003 U_8, where u/sub s/ is the surface drift current and U_8 is the wind speed at 6 m at Crib Point, in good agreement with observations made elsewhere in contained bodies of water. The continuous wind history over two years at the representative station of Crib Point is used to trace out the wind-induced component of drift for surface-residing materials split or discharged from each of 52 sites on the Bay and its environs.

41671 Recommendations of the working group on carbon in the atmosphere and in the ocean. Gieskes, J.M. (Scripps Institution of Oceanography, La Jolla, CA); Pytkowicz, R.M. pp 3-6 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

Recommendations are made with regard to the following; man's input of carbon dioxide into the atmosphere; monitoring stations for atmospheric CO_2; importance of land and ocean biota for uptake and release to the atmosphere of CO_2; air sea exchange of CO_2; and mixed layer-deep ocean exchange of CO_2. (HLW)

41672 Fossil fuel problem and carbon dioxide: an overview. Pytkowicz, R.M.; Small, L.F. (Oregon State Univ., Corvallis). pp 7-31 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

An overview of the carbon dioxide system in nature and its perturbation by man is presented in this work. Emphasis is plased upon an understanding of the factors that control this system, and on needed research, as a basis for predicting the impact of the burning fossil fuel.

41673 Influence of the Southern Oscillation on atmospheric carbon dioxide. Bacastow, R. (Scripps Institution of Oceanography, La Jolla, CA). pp 33-43 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

The atmospheric CO_2 record at the South Pole, after the seasonal effect is removed, reveals a small anomaly with a period of three to four years and an amplitude of about one part per million. The rate of change of this anomaly, and the corresponding anomaly at Mauna Loa, Hawaii, correlate well with the usual index of the Southern Oscillation. The Southern Oscillation is a large scale atmospheric and hydrospheric fluctuation involving wind strengths, ocean currents, and sea surface temperatures. Most directly, it is a fluctuation in the strength of the Pacific Trade winds, but the Southern Mid Latitude Westerlies also fluctuate in Phase. The correlations indicate that CO_2 is removed from the atmosphere at times of stronger than average Trade winds and Mid Lattitude Westerlies. It is suggested that CO_2 enters the Southern Mid Latidude oceans more rapidly during times of increased Westerlies. A more complete explanation of the relationship implied by the correlation should aid our understanding of how and where fossil fuel CO_2 enters the oceans.

41674 Hydrogen ions and the thermodynamic state of marine systems. Bates, R.G.; Culberson, C.H. (Univ. of Florida, Gainesville). pp 45-61 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

The influence of surface pH on the exchange of CO_2 between atmosphere and ocean is considered. Different acidity functions for seawater measurements are compared, and acidic dissociation constants in the carbonate system are critically examined as a function both of temperature and salinity.

41675 Seasonal patterns in suspended calcium carbonate concentrations during the dry and wet seasons in the eastern Caribbean. Betzer, P.R. (Univ. of South Florida, Tampa); Eggimann, D.W.; Carder, K.L.; Kester, D.R.; Betzer, S.B. pp 63-79 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

The concentration of suspended calcium carbonate was measured in samples taken in shallow and deep Caribbean waters during the dry and wet seasons of 1973 and 1974. During the dry season, suspended calcium carbonate was much more abudant throughout the water column. The marked reduction in particulate carbonate levels during the wet seasons may be related to: increases in the standing crop of zooplankton and, therefore, in the amounts of phytoplankton which are converted to rapidly-sinking fecal pellets; increases in the proportion of diatoms (at the expense of coccolithophores) among the primary producers in response to the input of soluble, riverine silicon to the open ocean; and a decrease in primary productivity, which is reflected in depressed numbers of coccolithophores.

41676 Modeling the oceans and ocean sediments and their response to fossil fuel carbon dioxide emissions. Bolin, B. (Univ. of Stockholm). pp 81-95 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

The continuity equation for the distribuuon of an arbitrary tracer in a water body is integrated with due regard to the basic characteristics of the ocean circulation to deduce a multiple reservoir model for the carbon cycle. Methods for evaluating the flux of carbon between the reservoirs are presented in some detail. Awaiting results from a series of model computations, some principle characteristics are pointed out, particularly the dependence of the downward flux of carbon into the sea on the sinking of detritus and thus, of the biological production in the surface layers of the ocean. The possible role of man's input of phosphorus into coastal waters (and possibly the open sea) is assessed.

41677 Atmospheric carbon dioxide and some interpretations. Machta, L.; Hanson, K.; Keeling, C.D. pp 131-144 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

The increasing amount of high quality benchmark carbon dioxide concentration data deserves critical analysis to improve our understanding of the entire carbon cycle. It is argued that the readily measured seasonal variation at benchmark stations outside of the Artic Region can be accounted for by land photosynthesis and decay of vegetation, and that the best record at Mauna Loa shows no evidence of a changing land biosphere (although the technique is not especially sensitive). It is also argued that the time changes of the residual concentration left after long-term trend and seasonal variation have been removed could be related to sea surface temperature in the El Nino region of the eastern Pacific Ocean off South America.

41678 Effects of enhanced CO_2 levels on growth characteristics of two marine phytoplankton species. Small, L.F.; Donaghay, P.L.; Pytkowicz,, R.M. (Oregon State Univ., Corvallis). pp 183-204 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

The chained marine diatom Skeletonema costatum and the unicellular marine chrysophyte Isochrysis galbana were batch-grown under 0.03%, 0.15%, and 0.30% CO_2 bubbled through the growth medium. The respective pH values stabilized at 8.2, 7.6, and 7.2 and the total alkalinity remained constant. The nitrate concentration was set to ultimately limit population yields, while the other nutrients were present in overabundance. The temperature and light were within appropriate natural ranges for the algal species. Both species showed some effect of enhanced CO_2 concentrations after nitrate exhaustion from the water, if the species were not first acclimated to the new CO_2 levels (cell clumping and stickiness were noted during the stationary growth phase). Acclimation to enhanced CO_2 levels could be accomplished if CO_2 levels were increased over one cell division, however. Acclimated cells showed no effect from bubbling increased CO_2 concentrations through the water (no changes were noted in growth rates, final population yields, intracellular fractionation of nitrogen, and the particulate franctions carbon/volume (C/V), nitrogen/volume (N/V), carbon/nitrogen (C/N), and fluorescence/volume (F/V)). In our simple systems, excess CO_2 in the water was not elaborated as algal tissue.

41679 Recommendations of the working group on carbonate dissolution. Broecker, W.S. pp 207-212 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

Recommendations are discussed with regard to the following factors: location of enhanced calcium carbonate dissolution in marine environment; marine calcium carbonate dissolution kinetics; calcium carbonate dissolution in sediments; and implications for marine and global geochemistry. (HLW)

41680 Neutralization of fossil fuel CO_2 by marine calcium carbonate. Broecker, W.S.; Takahashi, T. pp 213-241 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

The $CaCO_3$ stored in marine sediments will ultimately neutralize the CO_2 generated by fossil fuel combustion. Details of this process are explored and a model of the early phases of this process in the western basin of the deep Atlantic Ocean is presented. The amount of $CaCO_3$ available for dissolution is derived from the calcite content of marine sediments and the extent to which these sediments are stirred by benthic organisms. The conclusion is that the available calcite is about equivalent to the CO_2 which would be released if our known resources of natural gas, oil and coal were burned. The rate at which this dissolution will proceed is estimated from the rate at which natural dissolution has proceeded during the Holocene. The conclusion is that if linear kinetics are followed, the time constant will be on the order of 1500 years. On the other hand, if the exponential kinetics found in the laboratory apply, then the time constant will be much shorter. It is possible that the dissolution proceww will become limited by the rate stirring of the mixed layer in deep sea sediments. The insoluble residue of clay minerals and opal built up in the upper few millimeters of the sediment as the result of dissolution must be mixed down into the underlying sediment if more than the upper few millimeters of sediment is to be attacked.

41681 Carbonate saturation; disolution rate relationship. Boyle, E.A.; Edmond, J.M. (Massachusetts Inst. of Tech., Cambridge). pp 261-268 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

Although the re-cycling rate of calcium carbonate is usually presumed to be dependent on the degree of saturation of the deep ocean, the functionality of this relationship is not known. The saturation-dissolution relationship could be determined by measurements of recent carbonate sedimentation rates and separation of the effect of productivity variations from the effect of variations in the degree of saturation. Preliminary analysis suggests that the sediment dissolution rate is highly sensitive to small (i.e. 10%) shifts in the near-bottom saturation value.

41682 Biogenic carbonate particles in the ocean: do they dissolve in the water column. Honjo, S. (Woods Hole Oceanographic Institution, MA). pp 269-294 of Fate of fossil fuel CO_2 in the ocean. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

Excess CO_2 on the earth should eventually be neutralized in the ocean by the skeletal remains of calcite and aragonite produced by planktonic organisms particularly forminifera, coccolithophores and pteropods. The remineralization rates of biogenic carbonate, which controls the alkalinity adjustment of the ocean, is a function of their absolute dissolution rates. It is important to clarify the process and locality, how and where major remineralization occurs in the changing oceanic environment. The residence time of planktonic foraminiferan tests and pteropod shells is too short to undergo the significant dissolution while they are settling through the water column. On the other hand, the residence time and specific surface area of coccoliths is very large and their skeletons should be completely dissolved in the water column before arriving at the ocean floor. However, well preserved suspended coccoliths in undersaturated deep water have been collected. This paradox has been explained by invoking a two stage transportation hypothesis; first coccoliths descend with high speed within the fecal pellets of

grazers; secondly discrete coccoliths sink very slowly after having been shed from the host fecal pellet in the deep sea. Carbonate in fecal pellets are protected from undersaturated seawater and their residence time in the water column is short through the process of fast sinking.

41683 Effect of benthic biological processes on the CO_2 carbonate system. Paul, A.Z. (Comumbia Univ., NY). pp 345-354 of Fate of fossil fuel CO_2 in the ocean. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

Benthic organisms effect the dissolution of calcium caronate tests and particles through the following activities: the production of CO_2 by respiration increases the solubility of calcium carbonate; digestive processes strip organic coatings from calcium carbonate tests and shells allowing the undersaturated water to reach their surfaces; and bioturbation keeps the upper layer of sediments mixed and thus prevents calcium carbonate from being buried rapidly and lost to the system. Bioturbation is probably the most important factor and includes the following processes: organisms moving over or through the sediment; benthos eating the sediment and egesting feces or pseudofeces, or rejecting certain size grains; tube or burrow building activities of infauna; and sediment filling open burrows. Although benthic populations are not high there may be adaptations that permit processing of large quantities of sediment allowing the organisms to obtain their required nutrition from low organic carbon deposits. The meiobenthos (organism smaller than 0.5mm) may play an important role in the upper 1-2cm in deep-sea sediments.

41684 Benthic mixing in deep sea cores as determined by ^{14}C dating and its implications regarding climate stratigraphy and the fate of fossil fuel CO_2. Peng, T.H. (Columbia Univ., NY); Broecker, W.S.; Kipphut, G.; Shackleton, N. pp 355-373 of Fate of fossil fuel CO_2 in the ocean. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

A series of radiocarbon dates on Indian Ocean cor V19-188 reveals that this core was vertically mixed to a depth of 9 cm. Core top ^{14}C dates from a number of other areas also indicate that the sediment has been mixed to a depth ranging rom 6 to 18 cm. This mixing has important implications with regard to the fate of fossil fuel CO_2. A numerical model has been developed to study the effect of sediment mixing on radiocarbon dates, carbonate concentrations, oxygen isotopes and fauna abundances. This model indicates that the deviation of apparent ^{14}C ages from the true age ranges from 530 years to 1800 years for core V19-188, with the maximum deviation at the climatic transition depth.

41685 Carbon-13 in UVIGERINA: tropical rainforest history and the equatorial pacific carbonate dissolution cycles. Shackleton, N.J. pp 401-427 of Fate of fossil fuel CO_2 in the ocean. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

Benthonic forminifera in late Pleistocene deep-sea cores show significant variation in $\delta\ ^{13}C$ with depth in sediment. This indicates that $\delta\ ^{13}C$ in dissolved oceanic CO_2 undergoes a significant change in a few thousand years. This is in apparent contradiction to the estimated 300 ka residence time for carbon in the ocean. It suggested that this is a consequence of changes in the terrestrial plant biomass, which has a $\delta\ ^{13}C$ of about -25‰. Postulated changes in world vegetation, particularly in tropical rainforests during the Late Pleistocene, were sufficient to produce a change of the magnitude observed. Rapid expansion of forests between 13 ka and 8 ka ago may have resulted in the striking accumulation of aragonite pteropods in Atlantic Ocean sediments of that age. Rapid deforestation during an interglacial-glacial transition probably caused the intense carbonate dissolution which is observed in Equatorial Pacific Ocean sediments deposited over this interval. The current rate of injection of fossil fuel CO_2 into the atmosphere is substantially greater than the rate at which it was added during post-interglacial aridification in the tropics.

41686 Sediment mixing and carbonate dissolution in the southeast Pacific Ocean. Sundquist, E.; Richardson, D.K.; Broecker, W.S.; Peng, T.H. pp 429-454 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

Core descriptions of about 280 LDGO cores from the southeast Pacific Ocean indicate that a carbonate-rich top layer, noted by Broecker and Broecker (1974) in cores from the East Pacific Rise, is widespread at or near the calcite compensation depth. Sediment mixing is indicated in these cores by mottling and burrow structures and by discordance of C^{14} and thorium sedimentation rates. A simple mathematical mixing model suggests that the high-carbonate layer may have accumulated during a low stand of the compensation level in the last glacial period. However, in many cores the carbonate layer is not repeated in down-core cycles, as would be excores. Previous glacial carbonate peaks may have been largely dissolved during succeeding interglacials, or stirred into the most recent glacial layer along with small accumulations of interglacial noncarbonates. Box core studies should help to clarify the important influences of bioturbation on these problems.

41687 Mechanisms for calcite dissolution on the sea floor. Takahashi, T.; Broecker, W.S. (Columbia Univ., NY). pp 455-477 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

Arguments in support of the hypothesis that the major dissolution of $CaCO_3$ in the deep sea takes place within a few millimeters of the water-sediment interface are presented. Three models for the dissolution of $CaCO_3$ are considered: the stagnant boundary film model, and the constant variable resaturation time models. Assuming that the diffusive flux of CO_3 is equal to that of total CO_2 out of sediment, the validity of each model is tested using the $CaCO_3$ distribution in sediments observed in the Rio Grande Rise area. The stagnant boundary film model fails to adequately represent the data. The constant resaturation time model fits the data satisfactorily, and gives a characteristic calcite resaturation time consistent with the experimental value of 7 minutes. The variable resaturation time model when combined with the calcite solubility of Berner also fits the data satisfactorily, and predicts dissolution of calcite above the sedimentary lysocline. This prediction is consistent with the observation of Berger. However, the model requires that the rate of calcite dissolution increases with decreasing CO_3 concentrations at about one-fourth of the value obtained from the data of Berner and Morse.

41688 Recommendations of the working group on fate of fossil fuel CO_2 and the sedimentary record. Berger, W.H. (Scripps Institution of Oceanography, La Jolla, CA). pp 497-503 of Fate of fossil fuel CO_2 in the ocean. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

Recommendations are discussed with regard to the following; immediate response of the environment to increased carbon dioxide; long-term response of the environment; climatic effects of carbon dioxide increase; and possible remedial action to prevent excessive carbon dioxide levels. (HLW)

41689 Carbon dioxide excursions and the deep-sea record: aspects of the problem. Berger, W.H. (Scripps Institution of Oceanography, La Jolla, CA). pp 505-542 of Fate of fossil fuel CO_2 in the ocean. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

Deep-sea sediments bear on the CO_2 problem in three major ways: the sediment-ocean system is a powerful buffer for a geologically short-term CO_2 pulse like the present industrial input; deep-sea sediments provide a detailed record of the natural background fluctuation in climate against which a CO_2 induced change has to be measured; substantial CO_2 excursions may have occurred in the past, leaving a record in deep-sea sediment. The buffer action is mainly due to dissolution of calcareous sediments. Response is fastest in an ocean where dissolution effects are already widespread, such as the present one. The great extent of dissolution on the sea floor is evident from the shallowness of the R/sub o/-level, the level where formainiferal species lists first change noticeably. The lysocline (the level of maximum change) is about halfway between R/sub o/-level and CCD. Climatic fluctuations are thought to be tied to a large extent to astronomical causes. To verify this hypothesis, the dissolution have to be determined. Excursions of the saturation level during the Pleistocene (taken as change in the compensation depth of Globigerina rubescens) exceed 1 km and interfere with the signal produced by productivity changes alone.

41690 Sedimentatio on Ontong Java Plateau: observations on a classic "carbonate monitor". Berger, W.H. (Scripps Institution of Oceanography, La Jolla, CA); Johnson, T.C.; Hamilton, E.L. pp 543-567 of Fate of fossil fuel CO_2 in the ocean. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

Ontong-Java Plateau in the western equatorial Pacific is the classic example for a low-latitude deep-sea carbonate monitor. Box cores were taken, and seismic profiles were obtained on the Plateau for the study of the sedimentation processess governing the operation of the monitor. Properties of the sediments are greatly influenced by increasing dissolution of carbonate with depth of deposi-

tion and by winnowing processes above the lysocline. Burrowing patterns seen in the box cores depend on depth and suggest intermittent slow gravity flow in sub-lysoclinal calareous ooze. Seismic profiles indicate large-scale slumps whose morphology also depends on depth, and hence presumably on dissolution processes. It is proposed that much of the slumping arises from th removal of downslop support, at the lower flanks of the Plateau, by dissolution. It appears likely that both ooze flow and slumps are triggered by earthquakes generated at the nearby plate boundary. There is a general decrease of sedimentation rates with depth, but the scatter is considerable. Carbonate percentages are relatively inefficient predictors of changes in sedimentation rates, and hence of the amount of dissolution experienced. The origin of acoustic reflectors within carbonate sequences is obscure, but should be, at least in part, tied to cycles of dissolution, winnowing, and productivity, as well as to erosional surfaces. A close relationship of reflectors to depth-dependent zones of dissolution fluctuations could explain the striking differences between reflection profiles above the lysocline and the profiles from greater depth.

41691 Modulation of marine sedimentation by the continental shelves. Hay, W.W.; Southam, J.R. (Univ. of Miami, FL). pp 569-604 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

Estimates of the magnitudes of fluctuations in the mechanical and chemical loads of rivers through geological time are obtained by considering the relation between river loads and area, elevation, hypography, and climate of the present continental configuration. On long time scale it is whown that the continental shelves bypass material to deeper oceanic accumulation sites. However, for periods of rapidly rising sea level following glaciations, the sedimentation regime operates in such a way that continental margins consume a flux of $CaCO_3$ equal to or several times larger than the input from rivers. The initial effect on the ocean's sedimentation system due to the introduction of CO_2 by the burning of fossil fuels will be the dissolution of aragonite from shallow water tropical shelves.

41692 Organic carbon in deep-sea sediments. Heath, G.R.; Moore, T.C. Jr.; Dauphin, J.P. (Univ. of Rhode Island, Kingston). pp 605-625 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

The rate of accumulation of organic carbon in marine sediments is closely related to the bulk sediment accumulation rate and can be described by the equation: (Organic Carbon Accumulation Rate) = 0.01 (Sedimentation Rate) 1.4. Diagenetic reduction of the organic carbon content of older sediments appears to be exponential in both reduced and oxidized sediments, with half lives in the 15-55,000 year range. Pleistocene climate fluctuations have resulted in marked variations in the supply of organic carbon to the deep-sea, in part due to oceanographic changes, and in part due to the destruction of nearshore depositional environments by lowered sea level. Carbonate-rich deposits contain organic matter that is intimately associated with test calcite. The climate and carbonate effects can mask the diagenetic pattern evident in uniformly deposited sediments, but they do not alter the basic relation between organic-carbon and total-sediment accumulation rates.

41693 Carbonate accumulation and dissolution in the equatorial Pacific during the past 45 million years. Heath, G.R.; Moore, T.C. Jr.; van Andel, T.H. (Univ. of Rhode Island, Kingston). pp 627-639 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

Cenozoic carbonate-bearing sediments deposited beneath both the biologically productive equatorial zone and the less productive waters more than 4° from the equator in the central Pacific show decreasing accumulation rates with increasing water depth due to dissolution of carbonate at the sea floor. Below 3.5 km, the rate of dissolution increases linearly with depth. The vertical gradient of the dissolution rate has varied by a factor of thirty during the Cenozoic, from 0.6gm/cm^2/1000 yr/km during the Early Oligocene to probably reflect changes in bottom-water circulation due to tectonic and climatic changes during the past 45 million years. The calcite compensation depth beneath the equator dropped almost 2 km from the Late Eocene to the Early Oligocene, and rose about 500 m from the Middle to Late Miocene. Because of the higher vertical gradient of the Miocene dissolution rate, however, the Miocene rise represents about twice the reduction in carbonate supply as does the Eocene rise.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 40456, 41636, 41638, 41651

41694 (DP—1489, pp 93-96) **Par pond circulation patterns and plankton sampling.** Vigerstad, T.J.; Kiser, D.L. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

Circulatory patterns in a cooling reservoir in the vicinity of a hot water discharge can influence the temperatures experienced by biota in the reservoir. Sampling of Cladocera and subsequent dye studies in the Hot Arm of Par Pond (a cooling reservoir for nuclear reactor water on the Savannah River Plant) indicate that reactor effluents can be expected to transport biota from the limnetic portion of the lake in the vicinity of the effluent discharge to areas farther down the effluent-receiving-arm or to the littoral zone. This transport can confound sampling programs and complicate attempts to describe the thermal history of organisms.

41695 (DP—1489, pp 137-140) **Energy charge: an additional measurement of stress on biological systems.** Hanson, R.B. (Skidaway Inst. of Oceanography, Savannah, GA); Pope, D.H.; Fliermans, C.B. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

Production nuclear reactors at the Savannah River Plant (SRP) discharge large volumes of hot water into a variety of freshwater ecosystems. These ecosystems are basically affected in two ways: the effluent waters either severely alter the physical characteristics of the habitat so that only the simplest of microorganisms (i.e., bacteria and blue-green algae) exist, or the effluents more subtly affect the behavioral patterns of larger and structurally more-complex organisms. Our studies dealt with the first effect and measured primary productivity, temperature transfer, and energy charge. These data provided information as to the health and activity of the in situ algal communities attached to submerged substrates at various temperatures along the thermal effluent gradient present in the reactor discharge canals.

41696 (DP—1489, pp 229-231) **Plutonium in the Savannah River and marine environs.** Hayes, D.W.; Wong, K. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The concentration of plutonium is being measured in the Savannah River and marine environs to determine its transport fate, and dose-to-man. Plutonium transport was determined by analyzing samples collected synoptically by automatic samplers over a 2-year period. The plutonium transport (at an average Savannah River water concentration of 0.26 fCi/L) averaged 0.3 mCi/month. This transport rate results in a watershed loss rate of 0.0006%/month, based on an inventory of 55 Ci in the Savannah River watershed. Differences in plutonium water concentrations were found in three southeastern estuaries. The Newport Estuary in North Carolina was higher than the other two estuaries by a factor of ~4. This increase was probably caused by a) suspended particulate matter, and b) alterations in the sand, silt, and clay ratios of the suspended particulates in the different estuaries. Southeastern U.S. seafood samples were analyzed for plutonium. The 50-year dose commitment to an adult was estimated to be 4.4×10^{-4} mrem/year for mollusks, 2.4×10^{-5} mrem/year for crustaceans, and 3.4×10^{-5} mrem/year for fish (Table 1). These estimates assume ingestion of 11.8 kg/yr of fish or 5.9 kg/yr of mollusks and crustaceans.

WATER

REFER ALSO TO CITATION(S) 40440, 40443, 41626, 41643

THERMAL EFFLUENTS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 41627, 41665, 41694, 41757

41697 (DP—1489, pp 99-103) **Elemental gradients in macrophytes from a reactor effluent gradient.** Grace, J.B.; Tilly, L.J. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The tissues of submersed macrophtes from along the thermal gradient were analyzed for phosphorus to determine whether any pattern correspondent to standing crop distributions could be detected. Although water concentrations of phosphorus showed no detectable relationship to the thermal effluent, tissue concentrations of this element in submersed macrophytes declined with distance from the

effluent entry point. The occurrence of this concentration pattern suggests that phosphorus availability is greater near the discharge. Because phosphorus is the element most often determined to limit aquatic productivity, its greater availability may partially account for the apparent enhancement of macrophte growth near the thermal discharge. A patter of macrophyte abundance which indicated enchancement related to the discharge gradient in the reactor-cooling reservoir, Par Pond is reported. Correlative data tended to implicate light and temperature as important in influencing the differential abundance pattern.

41698 (DP—1489, pp 115-119) **Ten-month recolonization of the k-area cooling water system by the Asiatic clam Corbicula fluminea.** Harvey, R.S. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The Asiatic clam Corbicula fluminea was found in the Savannah River near Augusta, Georgia, in 1973. In 1975, Corbicula clogged heat exchangers and caused a shutdown of P Reactor, one of three operating nuclear production reactors (P, K, and C) at the Savannah River Plant (SRP). Clams were subsequently removed from K-Area and C-Area cooling water systems. At K Area, large volumes of river water are discharged into three 23-megaliter basins (Figure 1) where some settling occurs before the water is pumped through heat exchangers in the reactor area. The deposited silt provides a suitable substrate for Corbicula growth and reproduction. The silt must be removed at regular inervals to prevent heat exchanger pluggage arising from high populations of clams in the basins. The 186 basins at K Area were sampled to determine: the buildup of the Corbicula population since the basins were last cleaned, the size/age distribution of the clam population, and the occurrence of clam larvae. In addition, debris from flushes of Emergency Cooling Water Headers CW-39 and RW-1 were analyzed to determine: the relative abundance of live and dead clams, the size/age distribution of clams, and the volume of individual debris components.

41699 (DP—1489, pp 121-122) **Impingement of juvenile and adult fishes during cooling water withdrawal.** McFarlane, R.W. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

Juvenile and adult fishes are impinged upon trash removal screens as Savannah River water is withdrawn for use on the Savannah River Plant (SRP). Thirty-six species of fish, representing half of all riverine species known from the area, were impinged on the screens at three SRP pumping stations during 1977. Based on the average of 11.2 fish impinged per day, annual impingement is estimated to be 4088 fish. SRP thus ranks third lowest for impingement recently reported for 33 electric power plants.

41700 (DP—1489, pp 123-124) **Entrainment of ichthyoplankton and larval fishes during cooling water withdrawal.** McFarlane, R.W. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

Plantonic fish eggs and larvae are entrained into the Savannah River Plant (SRP) pumping system as Savannah River water is withdrawn for cooling purposes. The American shad contributed 96% of the planktonic fish eggs collected in the Savannah River. Eggs were rare in plankton samples from the intake canals and were assumed to have settled to the bottom as current velocity was reduced in the canal entrance. An estimated 72 million fish eggs were transported past the intake canals. Assuming "worst case conditions," 6.8 million eggs (9.5%) could have been lost due to entrainment. Blueback herring comprised nearly one-half of the 216 million fish larvae susceptible to impact. Spotted sucker and black crappie were also common among the 22 species of fish larvae collected. An estimated 19.6 million (9.1%) fish larvae could have been entrained under "worst case conditions".

41701 (DP—1489, pp 125-128) **Nitrification in thermally altered black-water streams.** Pool, A.C.; Fliermans, C.B. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

For each stream at each concentration of nitrite, a linear regression over time was performed. The generated slope represents the rate of change in the amount of nitrite nirogen present per hour in the chambers. The absolute value of the slopes (rate of nitrification) were plotted against the mean absolute temperature of the stream for the period of the experiment. The maximum rate of nitrification occurred at a temperature of 5° or 7.5°C above ambient. The maximum rate of nitrification occurred near 25°C. The nitrifying population appeared to have the highest densities in the 5.0° and 7.5°C above ambient streams. The data suggest that nitrification is enhanced by thermal alterations up to about 25°C (ΔT of 7.5°C); but above such levels, the rate of nitrification decreases. The density measurements of Nitrobacter futher support the observation that increased rates of nitrification are influenced by increases in temperature.

41702 (DP—1489, pp 129-132) **Bacterial pathogens in a reactor cooling reservoir.** Kasweck, K.L. (Florida Inst. of Tech., Melbourne); Fliermans, C.B. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The results of the sampling in both Par Pond and Clark Hill Reservoir are given. The frequency of isolation is a qualitative parameter which indicates how often the specified bacterium was isolated from each habitat. Initial scoping experiments demonstrated that a wider variety of pathogenic bacteria occur in Par Pond than in Clark Hill Reservoir. Such findings are interesting because Par Pond does not receive any human wastes directly, yet bacteria generally associated with human wastes are more frequently isolated from Par Pond. Previous studies have demonstrated that certain non-sporeforming enteric bacteria do not survive the intense heat associated with the cooling water when the reactor is operating. However, even when the reactor is not operating, cooling water, consisting of 10% makeup water from Savannah River, continues to flow into Par Pond. This flow provides a source of bacteria which inoculate Par Pond. Once the reactor is again operating, these same bacteria appear to be able to survive and grow within the Par Pond system. Thus, Par Pond and the associated lakes and canals of the Par Pond system provide a pool of pathogens that normally would not survive in natural waters.

41703 (DP—1489, pp 133-136) **Pathogenic species of thermophilic and thermotolerant fungi in reactor effluents of the Savannah River Plant.** Tansey, M.R. (Indiana Univ., Bloomington); Fliermans, C.B. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

Thermal effluent discharges from three nuclear production reactors at the Savannah River Plant (SRP). These effluents provide habitats with temperatures from ambient to 70°C, pH values which are not extreme, and environmental parameters which may be conducive to the growth of pathogenic species of thermophilic and thermotolerant fungi. This paper describes the diverse populations of thermophilic and thermotolerant fungi found in foam, water, microbial mats, plant debris, air, and soil associated with these reactor effluent habitats. Direct microscopic examination and quantitative culturing established that, except for the population of Dactylaria gallopova, populations of therotolerant and thermophilic fungi were not significantly different in elevated and ambient temperature sites. D. gallopava, a thermotolerant fungus pathogenic to young chickens and turkeys, is present in the mirobial mats, in foam, and in soils at the edges of the cooling water effluents which have temperatures above 43°C.

41704 (DP—1489, pp 155-156) **Periphytic algal species composition differences in thermally altered artificial streams.** Wilde, E.W. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

Initial studies of periphytic algal community structure on natural substrates in the six artificial streams at the Flowing Streams Laboratory were discussed in last year's annual report. These studies were continued throughout 1977 to determine seasonal patterns. The results indicated that: continuous temperature elevations of 5°C or 7.5°C could cause substantial changes in the seasonal periodicity of major algal taxa in a Southeastern U.S. blackwater stream, and a continuous temperature elevation of 12.5°C seriously affected algal community structure.

41705 (PB—287098) **Surface discharge of cooling water. Effects of distortion in model investigations.** Haeggstroem, S. (Chalmers Tekniska Hoegskola, Goeteborg (Sweden). Dept. of Hydraulics). 1978. 174p. NTIS PC A08/MF A01.

The investigation deals with the scaling effects that arise when the spread of cooling water is studied in a physical model with different horizontal and vertical length scale ratios. The investigation is limited to surface discharges under stationary conditions. Froude and Reynolds modelling practice is presumed. Different physical processes of importance are studied and the effects of distortion are evaluated. The analyses show that two-dimensional jet diffusion, buoyancy spread, and convective heat transport can, under certain conditions, be accurately reproduced in a distorted model. A three-dimensional nonbuoyant jet will, however, have a center-line excess temperature that is too great. For correct modelling of ambient diffusion special calibration is necessary. Analytical solutions to the spread of a buoyant surface jet indicate that the center-line excess temperature will be too great. Calculations using the Prych numerical model give similar results for discharges with high outlet densimetric Froude numbers but show also that a good agreement between model and prototype is achieved for discharges with a low densimetric Froude number. Analyses of laboratory experiments

confirm these theoretical results. For a distortion of eight, the areas within isotherms can be as much as 4-6 times too great. If the receiving body of water is shallow, then a better agreement between the model and the prototype can be achieved. Model-prototype comparisons show that a good agreement between the model and the prototype often demands the model to be calibrated for ambient diffusion.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 41049

REGULATIONS

REFER ALSO TO CITATION(S) 41111, 41589

ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 40464, 41020, 41094, 41107

41706 (DOE/TIC—10001) **Regional profile, energy-impacted communities: Regional VIII.** (Department of Energy, Denver, CO (USA). Region VIII). Mar 1979. 434p. Dep. NTIS, PC A19/MF A01.

This report has data on population, administration, finance, housing, health and safety, human services, education, and water and sewage for 325 energy-impacted communities. A review of current and potential energy developments in the region shows over 900 energy resource impacts listed for the 325 impacted communities. Coal development represents over one-third of the developments listed. Communities reporting coal development are distributed as follows: Colorado (36), Montana (42), North Dakota (61), South Dakota (13), Utah (73), and Wyoming (35). Energy-conversion initiatives represent another high incidence of energy-resource impact, with uranium development following closely with 83 communities reporting uranium development impact in the region. These projections indicate continued development of regional energy resources to serve national energy requirements. The 325 impacted communities as reported: Colorado (46), Montana (73), North Dakota (62), South Dakota (21), Utah (80), and Wyoming (43) follow a distribution pattern similar to that of future projects which illustrates that no area of the region will escape the impacts of energy development.

41707 (PB—287314) **Local perceptions of energy development: the case of the Kaiparowits Plateau.** Lovejoy, S.B. (Lake Powell Research Project, Los Angeles, CA (USA); Utah State Univ., Logan (USA); California Univ., Los Angeles (USA). Inst. of Geophysics and Planetary Physics). Nov 1977. 79p. NTIS PC A05/MF A01.

Proposed energy developments in the predominantly rural Four Corners area of the Southwest are threatening the residents' lifestyles. Data from a simple random sample of household heads in several rural communities in southern Utah and northern Arizona lend support to the proposition that the local citizens are eager to have large-scale energy projects in the Four Corners region. The citizens are active partners with industry in pressing for governmental approval of the projects and are willing to exchange elements of their current lifestyles for what are perceived as economic and employment benefits. The analysis presented here suggests that they tend to overemphasize the expected benefits while de-emphasizing, or remaining ignorant of, potential disadvantages resulting from such developments. Some explanations for this behavior are examined.

ASSESSMENT OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 41091, 41706

ENVIRONMENTAL IMPACT STATEMENTS

REFER ALSO TO CITATION(S) 40802

BIOMEDICAL SCIENCES, BASIC STUDIES

41708 (DP—1489, pp 151-154) **Evaluation of inverted microscope procedures for enumerating algae.** Wilde, E.W. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The following steps were incorporated into the standard methodology for inverted microscope algal enumerations at SRL: a minimum of 400 organisms (not cells) are counted from all samples; only settling chambers holding 10 mL or less are used; and a 63X planapochromatic objective lens is used for all enumerations of diatoms.

41709 **Effect of arm orientation on bone mineral mass and bone width measured using the Cameron—Sorenson technique.** Schlenker, R.A.; Kotek, T.J. (Center for Human Radiobiology, Radiological and Environmental Research Division, Argonne National Laboratory, Argonne, Illinois 60439). *Med. Phys.;* 6: No. 2, 105-109(Mar 1979).

Bone mineral content and bone width were measured at the distal and midshaft locations in the right radius and ulna with the arm in different orientations. The values of mineral content, width, and the ratio of bone mineral content divided by width, determined at each bone site were compared to establish the effect of orientation. Seven orientations were studied, two of which involved rotations of the forearm and five of which involved rotations of the upper arm about the axis of the forearm. Rotation of the forearm was found to affect the values of one or more of the measured quantities at all of the sites. Orientation of the upper arm was found to affect the values of all quantities at the midshaft radius, but not to affect the values of any of the quantities at the other sites.

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 41665, 41716, 41759, 41767

41710 (DP—1489, pp 143-145) **Fluorescence emission spectral differences among algae.** Wilde, E.W. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The fluorescence emission characteristics of a variety of living algal cells were recently measured. To our knowledge, this was the first time fluorometric spectral measurements of photosynthetic pigments from individual algal cells have been made. The fluorescence spectral patterns among individuals within a species were very consistent. Species within a major group (division) exhibited generally similar spectra, whereas distinct spectral differences occurred among some major groups.

41711 (UR—3490-1543) **"Aged" (dense) circulating red cells contain normal concentrations of ATP.** Kirkpatrick, F.H.; Muhs, A.G.; Kostuk, R.K.; Gabel, C.W. (Rochester Univ., NY (USA)). 1978. Contract EY-76-C-02-3490. 7p. Dep. NTIS, PC A02/MF A01.

A newly-developed technique for determination of the ATP content of individual red cells to the densest, and hence presumably the oldest, cells from normal human blood was applied. It was found that these cells contain normal concentrations of ATP, although the net content of ATP is decreased. The essence of the technique is suspension of red cells in autologous plasma containing luciferin and luciferase, lysis of the cells with a pulse from a laser, and counting of the photoemissions resulting from reaction of the released ATP with the luciferase. These data appear to disprove the otherwise plausible hypothesis of Lichtman that red cells decline exponentially in ATP content as they age, by one of the suggested tests of this hypothesis. The data suggest an alternative hypothesis: red cells maintain an approximately constant concentration of ATP as they age, and red cell destruction is caused by factors other than cellular ATP.

41712 **Thiobenzyl benzyloxycarbonyl-L-lysinate, substrate for a sensitive colorimetric assay for trypsin-like enzymes.** Green, G.D.J.; Shaw, E. (Brookhaven National Lab., Upton, NY). *Anal. Biochem.;* 93: No. 2, 223-226(Mar 1979).

Thiobenzyl benzyloxycarbonyl-L-lysinate (Z-Lys-SBzl) a substrate for trypsin-like proteases, was synthesized. In the presence of 5,5'-dithiobis(2-nitrobenzoic acid) the hydrolysis of the thiol ester by trypsin-like enzymes provides a continuous colorimetric assay with a sensitivity comparable to the best fluorometric substrates. Z-Lys-SBzl is readily synthesized in good yield, is water soluble, and has a low rate of spontaneous hydrolysis even at pH 8.0. This assay procedure has been routinely used with urokinase, human urinary and human plasma kallikrein, thrombin, plasmin, β-trypsin, factor Xa, and crotalase. Levels of detection of these enzymes are in the range 10^{-14} to 10^{-13} mol.

41713 Fluorescent labeling of fragments of high molecular weight RNA. Levinson, J.W.; Maher, V.M.; McCormick, J.J. (Michigan State Univ., East Lansing). *Anal. Biochem.;* 93: No. 3, 399-406(Mar 1979).

We describe a method to fluorescently label microgram quantities of high molecular weight RNA with acriflavine. The method involves hydrolyzing the RNA with HCl at pH 1.0 for 10 min to obtain segments of about 80 nucleotides. The 3'-terminal phosphate is removed from the ribose with alkaline phosphatase, and the terminal ribose is oxidized with periodate to form dialdehydes. Acriflavine is bound to the dialdehyde by the formation of a Schiff's base, and unbound acriflavine is removed by dialysis followed by chromatography on a Sephadex G-25 column eluted with phosphate buffered guanidine—HCl. Human 18 S rRNA bound 0.94 acriflavine molecules per 100 nucleotides and had a fluorescence excitation maximum at 460 nm and an emission maximum at 508 nm. If the hydrolysis step was omitted, this RNA bound only 0.12 acriflavine molecule per 100 nucleotides. Acriflavine-labeled high molecular weight yeast RNA showed a fluorescent intensity which was proportional to RNA concentration to a 1000-fold dilution.

TRACER TECHNIQUES

41714 (IS-T—842) Preliminary studies of the biosynthesis of Austin. Wicnienski, N.A. (Ames Lab., IA (USA)). Jan 1979. Contract W-7405-ENG-82. 89p. Dep. NTIS, PC A05/MF A01.

Thesis.

Aspergillus ustus is one of the most prevalent fungi in the soil. There are now two reports of the occurrence of toxin-producing strains of this fungus on stored foodstuffs. In addition, strains of A. ustus have been isolated along with Penicillium species from samples of South African cheeses. All A. ustus isolates tested were judged to be highly toxic to ducklings when grown on maize meal, however, the toxins involved were not isolated. Austin is the trivial name of one of the toxins made by the fungus found on stored food. Preliminary work to studying the biosynthesis of this compound using ^{13}C-labeled sodium acetate is reported here. The feasibility of the biosynthetic study was determined by feeding [1-^{14}C]-sodium acetate to A. ustus cultures. The assignments made in the ^{13}C-nmr spectrum of Austin are shown. The lowest dilution factor obtained in [1-^{14}C]-sodium acetate feeding experiments was 14. This dilution factor is sufficiently low to allow a successful feeding of [1,2-$^{13}C_2$]-sodium acetate. A new metabolite of A. ustus, deacetylaustin, was isolated and identified. An alkaloid of unknown structure was also isolated from the fungus.

CYTOLOGY

REFER ALSO TO CITATION(S) 41767

41715 (DP—1489, pp 147-149) **Algal preservation technique for use with fluorescence microscopy.** Wilde, E.W. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

Fluorescence microscopy provides many advantages over conventional light microscopy for algal examination. Use of this relatively new microscopical method for routine algal surveys requires a preservation technique in which intracellular chlorophyll pigments are well-preserved and fluorescence emission from the pigments is clearly observable. A technique involving the addition of 5% gluteraldehyde solution (50 wt %), followed by refrigeration, was found to fulfill both criteria and is currently being used for algal studies at SRL.

41716 (FDA—78-8042, pp 49-52) **Tumor and tumor-like lesions in the pituitary glands of beagles.** Hargis, A.M./ Thomassen, R.W. Aug 1978.

In CSU—FDA collaborative radiological health laboratory annual report, 1977.

This preliminary report describes the histology and histochemistry of normal, hyperplastic, and neoplastic pituitary cells in beagles, and defines criteria for classification of adenohypophyseal tumors. The use of glutaraldehyde fixation and selected histochemical stains aid in differentiation of pituitary cell types.

41717 (UR—3490-1594) **Quantification of erythroid and granulocytic precursor cells in plateletpheresis residues.** Abboud, C.N.; Brennan, J.K.; Lichtman, M.A.; Nusbacher, J. (Rochester Univ., NY (USA). School of Medicine and Dentistry; American Red Cross Blood Center, Rochester, NY). 1978. Contract EY-76-C-02-3490. 27p. Dep. NTIS, PC A03/MF A01.

Mononuclear cell fractions of human blood and plateletpheresis residues were compared for their content of hemopoietic precursor cells. Erythroid burst-forming units (BFU-E) averaged 560 +- 130 per ml of blood and granulocyte—monocyte colony forming units (CFU-C) averaged 240 +- 90 per ml blood. Estimates based on a blood volume of 7% of body weight indicate that the total blood pools of BFU-E and CFU-C are about 3.5×10^8 and 1.5×10^8 cells respectively. Sequential studies were performed over 3 days following one plateletpheresis in 4 donors. CFU-C and BFU-E approximately doubled between 48 and 72 hours after a plateletpheresis. During this time there was no significant alteration in the percent of null, T or B lymphocytes in blood. Thus, plateletpheresis appears to lead to a mobilization of precursor cells, which results in a transient increase in their concentration in blood. Therefore, pheresis 48 to 72 hours after an initial short-term procedure could harvest much larger numbers of precursor cells. Moreover, such techniques would put blood precursor cell content of plateletpheresis residues within reach of the precursor cell content in the volume of human marrow used for transplantation.

41718 Histone organization in chromatin: comparisons of nucleosomes and subnucleosomal particles from erythrocyte, myeloma, and yeast chromatin. Rill, R.L.; Nelson, D.A. (Florida State Univ., Tallahassee). *Cold Spring Harbor Symp. Quant. Biol.;* 42: 475-482(1978).

In this paper the major subnucleosomal and nucleosomal particles isolated from relatively inactive and active higher eukaryotic cell types (chicken erythrocytes and mouse myeloma tumors, respectively) and from the very transcriptionally active primitive eukaryote—baker's yeast are compared.

GENETICS

REFER ALSO TO CITATION(S) 41731, 41732

41719 (RLO—2225/5-39) **Multivariate normal genetic models with a finite number of loci.** Felsenstein, J. (Washington Univ., Seattle (USA). Dept. of Genetics). 1977. Contract EY-76-S-06-2225-005. 20p. Dep. NTIS, PC A02/MF A01.

A genetic model due to Russell Lande is described. The model assumes a finite number of loci at each of which there are an infinite number of alleles whose effects on the phenotype are normally distributed. Analytic and numerical results using this model depend on the allele effects remaining multivariate normally distributed. This is almost never exactly true, but may often be a good approximation. Numerical results for several kinds of natural selection are discussed. A model involving overdominance is presented which seems to exhibit the Franklin—Lewontin crystallization effect. A model is presented of the maintenance of genetic variation by a cline along which there is linear change in the optimum phenotype under optimizing selection. The equilibrium has been found analytically for the case of an infinite cline. Remarkably, there is no linkage disequilibrium maintained at equilibrium in this case.

41720 (UR—3490-1581) **Hybridization with synthetic oligonucleotides.** Szostak, J.W.; Stiles, J.I.; Tye, B.K.; Sherman, F.; Wu, R. (Cornell Univ., Ithaca, NY (USA); Rochester Univ., NY (USA). Dept. of Radiation Biology and Biophysics). 1978. Contract EY-76-C-02-3490. 17p. Dep. NTIS, PC A02/MF A01.

Procedures are described for the use of synthetic oligonucleotides for Southern blot experiments and gene bank screening, and the effect of various mismatches on the efficiency of hybridization is demonstrated. The following topics are discussed: sensitivity vs. specificity, hybridization of a 12-mer to the λ endolysin gene; hybridization of oligonucleotide probes to the E. coli lac operator; hybridization of synthetic probes to the CYC1 gene of yeast; and cloning eucaryotic genes. (HLW)

METABOLISM

REFER ALSO TO CITATION(S) 41754

MEDICINE

UNSEALED RADIONUCLIDES IN DIAGNOSTICS

REFER ALSO TO CITATION(S) 41726

41721 (PB—287647) **Technology in hospitals: medical advances and their diffusion. Summary report.** Russell, L.B. (Brookings Institution, Washington, DC (USA)). May 1978. 15p. NTIS PC A02/MF A01.

This study has examined seven hospital technologies that have become important over the last twenty-five years. It has taken a rather detailed look at each one, combining a case study of its use, costs, and benefits with statistical analyses of hospital survey data

that measure its diffusion or distribution, or both. The unprecedented growth of medical care costs in recent years, and in particular of hospital costs, has been largely due to the enormous amounts of resources that have been drawn into medical care some of which have taken the form of new technologies. The major purpose of the study has been to follow this particular strand in the growth of resources -- to discover what the resources are being used for and what is being gained in return, and to illustrate more clearly than any aggregate statistics can the nature of 'the cost problem'.

41722 (PB—287648) **Technology in hospitals: medical advances and their diffusion. Final report.** Russell, L.B. (Brookings Institution, Washington, DC (USA)). May 1978. 333p. NTIS PC A15/MF A01.

This study examines the diffusion of seven major hospital technologies -- intensive care, respiratory therapy, diagnostic radioisotopes, the electroencephalograph, cobalt teletherapy, open heart surgery, and renal dialysis -- in order to contribute to a better understanding of the growth of hospital costs. Case studies of the uses, resource requirements, and benefits of each technology are combined with statistical analysis, based on hospital survey data for the years 1961-75, of the influences that have been important in the adoption of these technologies by individual hospitals.

EXTERNAL RADIATION IN DIAGNOSTICS

REFER ALSO TO CITATION(S) 41721, 41722

EXTERNAL RADIATION IN THERAPY

REFER ALSO TO CITATION(S) 41721, 41722

UNSEALED RADIONUCLIDES IN THERAPY

REFER ALSO TO CITATION(S) 41721, 41722

MICROBIOLOGY

REFER ALSO TO CITATION(S) 41648, 41731, 41732, 41764

41723 **Site selection for microbiological processing (as illustrated by the Arlan high-viscosity and density oil field).** Yulbarisov, E.M. *Neftеprom. Delo;* No. 3, 4-6(1978). (In Russian).

In r ,onsideration of the important problem of increasing oil bed yields, an examination is made of one of the most important problems in the practical use of microorganisms in gas and oil recovery. An evaluation is made of the geological-physical conditions of the Arlan field where the following industrial experiment was conducted. Used as the active agent was the natureal biocenosis of peat and slime formations that include a complex of anaerobic and aerobic bacteria which made it possible to minimize expenditures for the reagent's preparation. MIcroorganic adaptation was performed under terrestrial conditions in special troughs by the addition of oil and stratal water from the oil field being treated. The bioreagent was pumped through a pressure well so that there would be no losses of oil and gas resulting from the technology of treating the bed. The biochemical processes produced a higher coefficient of oil recovery by 12% in the bed's flooding area and an increase in the operational rate of the experimental site in comparison to the usual flooding methods, because of an increase in the gas factor, a reduction in oil density and viscosity and the larger bed area covered by flooding. The experimental results confirmed that the distribution of active bacteria is determined by the general geochemical situation in the beds, and primarily depends on the degree of the structure's exposure. The content of nutritive elements, the oil's chemical composition and density are most important for microbiological activity. The intensity of development is influenced by temperature pH and salinity of stratal waters and the resevoir's permeability in various directions. These factors should be the basic criteria for selecting a site (field) for microbiological activity. A number of technological measures was suggested for approximating the physico-chemical conditions of a stratal medium that would be optimal for microorganic viability.

41724 (COO—4546-7) **Improved enzymatic conversion of cellulose by ethylene treatment. Final report of innovative research program subtask, December 1977—September 1978.** Linden, J.C.; Murphy, V.G. (Colorado State Univ., Fort Collins (USA). Solar Energy Applications Lab.). Oct 1978. Contract EG-77-S-02-4546. 8p. Dep. NTIS, PC A02/MF A01.

The stimulating effect of ethylene upon the enzymatic hydrolysis of cellulose was investigated to determine the mechanism of the stimulatory action. The mechanism was not determined; however, it was tentatively concluded that prolonged ethylene treatment unmasks the cellulose by dissolving contaminating materials such as lignin, hemicellulose, pectin, or ash. The presence of ethylene during the enzymatic hydrolysis appears to involve enzyme-substrate interactions in many cases. The evidence supports the opinion that a 20 to 40% improvement in the rate of enzymatic hydrolysis of cellulose may be obtained by the use of ethylene in the enzyme reactor. (JSR)

41725 **Expression of baboon endogenous virus in exogenously infected baboon cells.** Lavelle, G. (Oak Ridge National Lab., TN); Foote, L.; Heberling, R.L.; Kalter, S.S. W-7405-ENG-26. *J. Virol.;* 30: No. 1, 390-393(Apr 1979).

Strains of low-passage, fetal diploid, baboon (Papio cynocephalus) fibroblasts were susceptible to exogenous infection with three independent isolates of baboon endogenous virus, as measured by an immunofluorescence assay specific for viral p28. Infectivity of the M7 strain of baboon endogenous virus for baboon cells of fetal skin muscle origin was equivalent to that for human and dog cells in that similar, linear, single-hit titration patterns were obtained. The assay for supernatant RNA-dependent DNA polymerase, however, showed that baboon cells produced only low levels of virus after infection compared with the production by heterologous cells. The results showed that baboon endogenous virus was capable of penetrating baboon cells and that viral genes were expressed in infected cells. Replication of complete infectious virus was restricted, however, indicating that in this primate system homologous cells differentially regulated the expession of viral genes.

PATHOLOGY

REFER ALSO TO CITATION(S) 41668, 41740, 41753, 41764, 41767

TRACER TECHNIQUES

41726 (UR—3490-1550) **Mammary tumors and serum hormones in the bitch treated with medroxyprogesterone acetate or progesterone for four years.** Frank, D.W.; Kirton, K.T.; Murchison, T.E.; Quinlan, W.J.; Coleman, M.E.; Gilbertson, T.J.; Feenstra, E.S.; Kimball, F.A. (Upjohn Co., Kalamazoo, MI (USA); Dawson Research Corp., Orlando, FL (USA); Rochester Univ., NY (USA). Dept. of Radiation Biology and Biophysics). 1978. Contract EY-76-C-02-3490. 21p. Dep. NTIS, PC A02/MF A01.

After four years of a long term contraceptive steroid safety study, the incidence and the histologic type of mammary dysplasia produced is similar in beagles treated with medroxyprogesterone acetate (medroxyprogesterone) or progesterone. Serum insulin, thyroid stimulating hormone (TSH), triiodothyronine, growth hormone, prolactin, 17β-estradiol, progesterone, and cortisol were determined by radioimmunoassay on samples collected after 45 months of treatment. Serum growth hormone and insulin concentrations were elevated in a dose related manner in both treatment groups. Triiodothyronine, cortisol, and estradiol-17β (medroxyprogesterone only) were lowered. TSH and prolactin concentrations were not changed. Pituitary—gonadal hormone interaction in the pathogenesis of mammary neoplasia of the dog is discussed. Prolonged treatment of the beagle with massive doses of progesterone or medroxyprogesterone results in a dose related incidence of mammary modules.

PHYSIOLOGICAL SYSTEMS

REFER ALSO TO CITATION(S) 41753, 41764

AGRICULTURE AND FOOD TECHNOLOGY

REFER ALSO TO CITATION(S) 41015, 41035, 41060, 41074

41727 (SAND—79-0182, pp 77-102) **Prospective usage of sewage solids as feed for cattle.** Smith, G.S.; Kiesling, H.E.; Ray, E.E. (New Mexico State Univ., Las Cruces). Feb 1979.

From Sandia irradiator for dried sewage solids seminar and dedication; Albuquerque, NM, USA (18 Oct 1978).

Feed consumption was decreased by sewage solids, especially during the first two weeks; but there was no evidence of toxicity or impaired reproduction. Levels of Fe and Pb in livers and kidneys were increased over values for experimental control animals, but not beyond levels reported for animals fed conventionally. Subsequent feeding of a conventional diet for 56 days reduced liver and kidney Fe and Pb to levels observed in controls. Levels of Ag, Ca, Cd, Cr, Hg, K, Mg, Mn, Na, Ni, P, and Zn were significantly affected; but Cu was decreased ($P < 0.10$) in livers at 68 days. Dietary sewage solids caused detectable increases in 5 of 22 pesticide residues measured in adipose tissue after 68 days, but none of these were outside ranges reported for cattle fed conventionally. In another trial, 75 gestating-lactating beef cows were pastured on rangeland

with dormant forage for 95 days. Twenty-five received no supplement feed; 25 were fed cottonseed meal (CSM); and 25 were fed supplements with 62% sewage solids. CSM was consumed at two pounds per head twice weekly, whereas the supplement with sewage solids was consumed at 1.5 to 1.8 pounds per head twice weekly. Both supplements increased ($P < 0.05$) calf weights over unsupplemented controls. Results suggest that sewage solids could be used as a range supplement with little risk to cattle or the human food chain.

41728 (SAND—79-0182, pp 103-122) **Effect of using gamma radiation treated digested sewage sludge on calcareous soil.** McCaslin, B.D.; Rodriguez, V.L. (New Mexico State Univ., Las Cruces). Feb 1979.

From Sandia irradiator for dried sewage solids seminar and dedication; Albuquerque, NM, USA (18 Oct 1978).

The use of gamma-radiation-treated digested sewage sludge (RDSS) as a fertilizer is being examined in cooperation with Sandia Laboratories, Applied Biology and Isotope Utilization Division (Albuquerque, NM), under contract with the United States Department of Energy, Albuquerque Operations Office. Greenhouse experiments were conducted to examine the use of RDSS as a fertilizer for three successive plantings of grain sorghum grown on a typical calcareous soil known to be deficient in plant-available Fe. The experiments consisted of nine treatments total, from 0 to 50 metric ton/ha (10 ton/ha intervals), 381 metric ton/ha, pure RDSS, and one standard fertilizer material check treatment. The fertilizer materials were applied once; then 3 successive crops of sorghum were grown. Sorghum dry matter production tended to increase as RDSS rates increased and tended to increase with successive harvests. Plants grown in the pure RDSS and 381 metric ton/ha treatments failed to live through the first growth period, largely due to total soluble salt contents. In the third cropping, pure RDSS and the 381 metric ton/ha rates produced the highest yields. Total soluble salt concentrations of the RDSS were apparently the most limiting factor of RDSS usage under these experimental conditions.

41729 **System aspects of agricultural energy conservation.** Taussig, R.T.; Holt, E.A. (Mathematical Sciences Northwest, Inc., Bellevue, WA). pp 503-511 of Energy use management. Fazzolare, R.; Smith, C.B. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International conference on energy use management; Tucson, AZ, USA (24 Oct 1977).

One of the most-impressive characteristics of the food-delivery system from farm production to the consumer's dinner plate, is the interdependence of energy use among its different components. The energy consumed in any one component of the system varies by type of crop grown, cultivation and harvesting techniques, food-processing technology, mode of transport, requirements for food storage, and food-preparation practices. Of special significance is the fact that the amount and type of energy consumed at each stage in the delivery system from production to consumption depends on the preceding and following stages. Shifts in crop type, implementation of new modes of operation and more-efficient equipment, adjustments in modal transportation split, and changes in consumer preference all promise to yield substantial energy savings in individual sectors of the food system. In an attempt to develop an effective agriculture energy conservation plan for implementation in Washington State in 1977 to 1980, the authors analyzed energy interdependencies for the agricultural sector. They report on the system-wide energy trade-offs involved in the conservation measures considered and proposed, and reflect on the problem this poses to regional energy planners faced with formulating agricultural energy-conservation plans. Specific examples include changes in produce from frozen to fresh form and changes in food-preparation techniques.

BIOMEDICAL SCIENCES, APPLIED STUDIES

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 41621

RADIATION EFFECTS ON MICROORGANISMS

BASIC STUDIES

41730 (SAND—79-0182, pp 37-52) **Pathogen reduction in sludges by irradiation.** Brandon, J.R. (Sandia Labs., Albuquerque, NM). Feb 1979.

From Sandia irradiator for dried sewage solids seminar and dedication; Albuquerque, NM, USA (18 Oct 1978).

There is international interest in the use of ionizing radiation in waste water and sludge treatment. Results of programs to study effects of radiation on disease-causing microbes commonly found in wastewater sludges will be discussed. Although emphasis will be on the work conducted at Sandia Laboratories, the discussion will include work in progress in West Germany, France, South Africa, and other countries.

41731 (UR—3490-1570) **Decreased uv mutagenesis in cdc8, a DNA replication mutant of Saccharomyces cerevisiae.** Prakash, L.; Hinkle, D.; Prakash, S. (Rochester Univ., NY (USA)). 1978. Contract EY-76-C-02-3490. 40p. Dep. NTIS, PC A03/MF A01.

A DNA replication mutant of yeast, cdc8, was found to decrease uv-induced reversion of lys2-1, arg4-17, tryl and ural. This effect was observed with all three alleles of cdc8 tested. Survival curves obtained following uv irradiation in cdc8 rad double mutants show that cdc8 is epistatic to rad6, as well as to rad1; cdc8 rad51 double mutants seem to be more sensitive than the single mutants. Since uv-induced reversion in cdc8 rad1 and cdc8 rad51 double mutants is like that of the cdc8 single mutants, we conclude that CDC8 plays a direct role in error-prone repair. To test whether CDC8 codes for a DNA polymerase, we have purified both DNA polymerase I and DNA polymerase II from cdc8 and CDC+ cells. The purified DNA polymerases from cdc8 were no more heat labile than those from CDC+, suggesting that CDC8 is not a structural gene for either enzyme.

41732 (UR—3490-1571) **Effects of the rad52 gene on recombination in Saccharomyces cerevisiae.** Prakash, S.; Prakash, L.; Burke, W.; Montelone, B.A. (Rochester Univ., NY (USA). Dept. of Biology; Rochester Univ., NY (USA). Dept. of Radiation Biology and Biophysics). 1979. Contract EY-76-C-02-3490. 32p. Dep. NTIS, PC A03/MF A01.

Effects of the rad52 mutation in Saccharomyces cerevisiae on meiotic, γ-ray-induced, uv-induced, and spontaneous mitotic recombination were studied. The rad52/rad52 diploids undergo premeiotic DNA synthesis; sporulation occurs but inviable spores are produced. Intra- and intergenic recombination during meiosis were examined in cells transferred from sporulation medium to vegetative medium at different time intervals. No intragenic recombination was observed at the his1-1/his1-315 and trp5-2/trp5-48 heteroalleles. Gene-centromere recombination was also not observed in rad52/rad52 diploids. No γ-ray-induced intragenic mitotic recombination is seen in rad52/rad52 diploids and uv-induced intragenic recombination is greatly reduced. However, spontaneous mitotic recombination is not similarly affected. The RAD52 gene thus functions in recombination in meiosis and in γ-ray and uv-induced mitotic recombination but not in spontaneous mitotic recombination.

RADIATION EFFECTS ON ANIMALS

MAN

REFER ALSO TO CITATION(S) 41627, 41635, 41752

41733 (CONF-780819—P2, pp 935-945) **Some perspectives on radiation protection.** Sinclair, W.K. (National Council on Radiation Protection and Measurements, Washington, DC). Feb 1979.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

A brief review of the history and organizational structure of the NCRP is given. Summaries are given of a number of NCRP radiation protection guides dealing with hazards from ^{85}Kr, radiation exposures from consumer products, basic radiation protection criteria, and doses from natural background radiation.

41734 (CONF-790316—2) **Natural background approach to setting radiation standards.** Adler, H.I.; Federow, H.; Weinberg, A.M. (Oak Ridge National Lab., TN (USA); Oak Ridge Associated Universities, Inc., TN (USA). Inst. for Energy Analysis). 1979. Contract W-7405-ENG-26. 12p. Dep. NTIS, PC A02/MF A01.

From Topical seminar on the practical implications of the ICRP recommendation and the revised IAEA basic standards for radiation protection; Vienna, Austria (5 Mar 1979).

The suggestion has often been made that an additional radiation exposure imposed on humanity as a result of some important activity such as electricity generation would be acceptable if the exposure was small compared to the natural background. In order to make this concept quantitative and objective, we propose that small compared with the natural background be interpreted as the standard deviation (weighted with the exposed population) of the natural background. This use of the variation in natural background radiation is less arbitrary and requires fewer unfounded assumptions than some current approaches to standard-setting. The standard deviation is an easily calculated statistic that is small compared with the mean

value for natural exposures of populations. It is an objectively determined quantity and its significance is generally understood. Its determination does not omit any of the pertinent data. When this method is applied to the population of the United States, it suggests that a dose of 20 mrem/year would be an acceptable standard. This is comparable to the 25 mrem/year suggested as the maximum allowable exposure to an individual from the complete uranium fuel cycle. (ERB)

41735 (DP—1489, pp 237-238) **Regional, U.S., and global population dose consequences from reprocessing nuclear fuels at an AFCT/TFCT fuel reprocessing facility.** Schubert, J.F. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The objective of the Environmental Effects Program is to provide state-of-the-art methods for assessing dose consequences of routine releases to the environment from spent fuel reprocessing in an alternate fuel cycle technologies (AFCT), thorium fuel cycle technologies (TFCT) complex. Studies are also being conducted to assess the dose consequences from an International Spent Fuel Storage (ISFS) facility. The population dose consequences will be examined at the regional (one to two state area), U.S., and global scales. Computer systems support in the form of applications independent software was developed to support the phased environmental data base. The data base permits access and exchange between the participating laboratories. The objective of the computer systems support is to integrate, at SRL, the data bases and simulations methodology of participating Department of Energy (DOE) laboratories. This capability is being used for the population dose assessments and will also provide support for the follow-on objectives of the ARCT/TFCT/ISFS program.

41736 (INIS-mf—4602) **Order of 6 October 1977 defining the characteristics of each type of large nuclear installation.** (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1978. 2p. (In French). Dep. NTIS (US Sales Only), PC A41/MF A01.

This Order, made by the French Minister of Industry, Commerce and Crafts and the Minister of Labour, lays down the characteristics of large nuclear installations which should be included in the document provided for under Section 10 of decree No. 75-306 of 28 April 1975 on the protection of workers against the hazards of ionizing radiation in large nuclear installations. These include inter alia the reactor type, its nominal power, the nature and cladding of the fuel, the rate of loading/unloading of the fuel, provisions to prevent criticality risks outside normal operation of the reactor, controlled areas and the measures for protection against ionizing radiation. The Order also lays down the characteristics for plants for the preparation and treatment of irradiated nuclear fuels as well as the characteristics of facilities for the storage, use, manufacture and transformation of radioactive substances, and the maximum permissible annual quantities of radioactive releases.

41737 (INIS-mf—4603) **Order of 7 October 1977 of the periodicity on controls in large nuclear installations.** (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1978. 1p. (In French). Dep. NTIS (US Sales Only), PC A02/MF A01.

This Order was made in implementation of Section 24 of Decree No. 75-306 of 28 April 1975 on the protection of workers against the hazards of ionizing radiation in large nuclear installations, and lays down that shields for protecting staff against radiation and for radiation emitting devices must be controlled every three years; sealed sources, their premises, ventilation and filtrating devices must be controlled every year and finally, radiation detecting devices must be controlled on a monthly basis.

41738 (INIS-mf—4604) **Order of 10 october 1977 on the special safety measures applicable to certain large nuclear installations.** (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1978. 2p. (In French). Dep. NTIS (US Sales Only), PC A02/MF A01.

This Order by the Minister of Industry, Commerce and Crafts and the Minister of Labour was made in implementation of Section 40 of Decree No. 75-306 of 28 April 1975 on the protection of workers against the hazards of ionizing radiation in large nuclear installations. It lays down the safety measures applicable to nuclear reactors and ancillary facilities, particle accelerators, irradiated fuel reprocessing plants and facilities for the storage of radioactive waste.

VERTEBRATES

41739 (CONF-790229—3) **Carcinogenesis in mice after low doses and dose rates.** Ullrich, R.L. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 37p. Dep. NTIS, PC A03/MF A01.

From 32. annual symposium on fundamental cancer research; Houston, TX, USA (27 Feb 1979).

The results from the experimental systems reported here indicate that the dose-response curves for tumor induction in various tissues cannot be described by a single model. Furthermore, although the understanding of the mechanisms involved in different systems is incomplete, it is clear that very different mechanisms for induction are involved. For some tumors the mechanism of carcinogenesis may be mainly a result of direct effects on the target cell, perhaps involving one or more mutations. While induction may occur, in many instances, through such direct effects, the eventual expression of the tumor can be influenced by a variety of host factors including endocrine status, competence of the immune system, and kinetics of target and interacting cell populations. In other tumors, indirect effects may play a major role in the initiation or expression of tumors. Some of the hormone-modulated tumors would fall into this class. Despite the complexities of the experimental systems and the lack of understanding of the types of mechanisms involved, in nearly every example the tumorigenic effectiveness per rad of low-LET radiation tends to decrease with decreasing dose rate. For some tumor types the differences may be small or may appear only with very low dose rates, while for others the dose-rate effects may be large.

41740 (FDA—78-8042) **CSU—FDA collaborative radiological health laboratory annual report, 1977.** (Colorado State Univ., Fort Collins (USA). Coll. of Veterinary Medicine and Biomedical Sciences; Bureau of Radiological Health, Rockville, MD (USA). Div. of Biological Effects; Colorado State Univ., Fort Collins (USA). Collaborative Radiological Health Lab.). Aug 1978. 125p. BRH Technical Information Staff, Rockville, MD.

Results are reported for two long-term radiation effects studies involving beagles. The studies were designed to (1) characterize prenatal development and short-term prenatal sensitivity; (2) determine the relative radiosensitivity in terms of acute lethality; (3) examine delayed effects occuring within a few years following exposure within the LD_{50} range at these ages. Individual entries were made for some of the sections.

41741 (FDA—78-8042, pp 5-9) **Cumulative mortality statistics for segment III beagles of the CRHL long-term study.** Angleton, G.M.; Thomassen, R.W.; Benjamin, S.A. Aug 1978.

In CSU—FDA collaborative radiological health laboratory annual report, 1977.

Tables for cumulative mortality statistics for Segment III beagles of the CRHL Long-Term Study are presented. No effects because of irradiation appear to be maniifested in the mortality data available at this stage of the study. The statistics for the cumulative probabilities of survival for beagles entered into the Segment III of the CRHL Long-Term Study are being studied relative to testing null hypotheses on the existence of irradiation effects.

41742 (FDA—78-8042, pp 10-21) **Principal disease or cause of death in nonsacrifice beagles receiving gamma radiation during development.** Thomassen, R.W.; Hargis, A.M.; Benjamin, S.A. Aug 1978.

In CSU—FDA collaborative radiological health laboratory annual report, 1977.

Epilepsy, hypothyroidism, cor pulmonale, and neoplasia are the leading causes of death of Segment III beagles, accounting for 90 to 208 fatalities from 1968 through 1977. Of the four, only neoplasia appears to be related to radiation history. Fifteen of 16 dogs dying of neoplasia were irradiated. Nine of these were exposed at either 55 days post coitus (dpc) or 2 days post partum (dpp).

41743 (FDA—78-8042, pp 22-25) **Long-term segment III beagles scheduled for sacrifice. A progress report.** Thomassen, R.W. Aug 1978.

In CSU—FDA collaborative radiological health laboratory annual report, 1977.

Presacrifice tests and gross necropsy examinations have been completed on the 140 beagles scheduled for sacrifice at 5 years of age and 28 of 140 dogs scheduled for sacrifice at 8 years of age. Sacrifice of 11-year-old dogs is scheduled to begin in 1979, and a sufficient number of dogs should survive to complete this segment. It is anticipated, however, that only a fraction of the dogs will be available for sacrifice at 14 years of age.

41744 (FDA—78-8042, pp 26-34) **Gross and surgical pathologic findings in beagles receiving gamma radiation during development and sacrificed at 5 or 8 years of age.** Thomassen, R.W.; Hargis, A.M.; Benjamin, S.A. Aug 1978.

In CSU—FDA collaborative radiological health laboratory annual report, 1977.

Gross necropsy examinations have been completed on each of the 140 beagles scheduled for sacrifice at 5 years of age and on 28 of 140 beagles for sacrifice at 8 years of age. To date, the only major gross pathologic changes that are correlated with radiation treatment are an unusual number of testicular tumors occurring in irradiated dogs, especially in those receiving 100R at 55 days postcoitus and sacrificed at 5 years of age.

41745 (FDA—78-8042, pp 35-39) **Neoplasms in dogs receiving low-level gamma radiation during pre- and postnatal development.** Benjamin, S.A.; Thomassen, R.W.; Hargis, A.M.; Angleton, G.M.; Lee, A.C. Aug 1978.

In CSU—FDA collaborative radiological health laboratory annual report, 1977.

Mortality because of neoplasia was examined in Segment III dogs exposed to 0,20, or 100 R of ^{60}Co gamma radiation in prenatal and early postnatal life. During the inital 10 years of the experiment (through January 31, 1978) 20 dogs died or were killed because of neoplasia, 19 having been irradiated. Tumors in these 19 irradiated dogs included 5 malignant lymphomas, 8 carcinomas (2 of mammary origin, 2 of prostatic origin, and 1 each or oral mucosa, ovary, urinary bladder, and thyroid origin), 4 sarcomas (2 hemangiosarcomas, 1 fibrosarcoma and 1 mast cell sarcoma), 1 astrocytoma, and 1 hepatocellular adenoma. Neoplasms occurred in all irradiated groups except 8 dpc (20 and 100R) and 70 dpp (100R). Eleven neoplasms developed in dogs irradiated perinatally (55 dpc or 2 dpp) with 20 or 100R. Four of the tumors in the perinatally irradiated dogs were detected before 2 years of age. The earliest death was at 3 months, because of an astrocytoma. A single sham-irradiated dog died or a malignant tumor, a mammary carcinoma. Preliminary analyses point to three findings of particular interest: the preponderance of neoplasms causing death or euthanasia occurred in irradiated dogs, the unusual finding of four deaths because of neoplasia prior to 2 years of age in perinatally irradiated dogs, and the occurrence of five malignant lymphomas in this relatively small irradiated population.

41746 (FDA—78-8042, pp 40-43) **Radiation effects for segment III beagles as manifested by birthweight data.** Angleton, G.M.; Lee, A.C.; Simpson, J.C. Aug 1978.

In CSU—FDA collaborative radiological health laboratory annual report, 1977.

Birthweight data for Segment III beagles were analyzed for dose effects taking into account inter- and intralitter effects. No significant dose effects were noted for exposures given 8 and 55 dpc. However, a highly significant curvilinear response pattern resulting in decreased weight with increasing dose was noted in exposures given 28 dpc.

41747 (FDA—78-8042, pp 44-47) **Estimated cumulative probabilities for clinical eye lesion occurrence in beagles irradiated at various ages.** Lee, A.C.; Angleton, G.M.; LoPresti, C.A. Aug 1978.

In CSU—FDA collaborative radiological health laboratory annual report, 1977.

Estimated cumulative probabilities are presented for the occurrence of clinically recognizable eye lesions in beagles exposed to whole-body ^{60}Co gamma radiation at various ages. The probabilities were calculated using the clinical data that has been entered into the computer data base, representing approximately 75 percent of the available information. Increases in probability appear to be related more to attained age of the dogs than to experimental parameters.

41748 (FDA—78-8042, pp 53-55) **Preliminary considerstions for an in-depth investigation of thyroid disease in the CRHL beagle colony.** Stephens, L.C.; Norrdin, R.W.; Thomassen, R.W. Aug 1978.

In CSU—FDA collaborative radiological health laboratory annual report, 1977.

This report describes preliminary results of evaluation of selected clinical laboratory data from hypothroid and euthyroid beagles as an initial step in an in-depth study of hypothyroidism in the CRHL colony. Both hyperchloesterolemia and a decreased hematocrit were present in dogs with clinically diagnosed or pathologically confirmed thyroid disease.

41749 (FDA—78-8042, pp 56-59) **Tumor and tumor-like lesions of the perilimbal conjunctiva in beagles.** Hargis, A.M.; Lee, A.C.; Thomassen, R.W. Aug 1978.

In CSU—FDA collaborative radiological health laboratory annual report, 1977.

Review of clinic and pathology records of 1,680 Segment III beagles revealed proliferative and neoplastic lesions in the nasal or temporal limbal conjunctiva of 8 male and 6 female dogs. The average age at diagnosis was 6.2 years. The lesions were of epithelial or endothelial origin and they developed under circumstances suggesting that solar radiation was involved in the pathogenesis.

41750 (FDA—78-8042, pp 60-65) **Extra-renal effects of perinatal irradiation: clinical metabolic studies on beagles with chronic renal failure.** Norrdin, R.W.; Miller, C.W.; LoPresti, C.A. Aug 1978.

In CSU—FDA collaborative radiological health laboratory annual report, 1977.

Studies on perinatally irradiated beagles that developed progressive renal failure revealed no gross disturbance in serum Na, K, Cl, or HCO_3. There was mild intermittent acidosis in some of the dogs, and increased urinary excretion of Ca, P, and hydroxyproline. Serum P became elevated with declining renal function but serum Ca did not change. Most of the findings were attributable to renal secondary hyperparathyroidism. The increased urinary excretion of Ca may represent a specific defect.

41751 (FDA—78-8042, pp 66-74) **Renal function changes associated with aging and ionizing radiation.** Miller, C.W.; Norrdin, R.W.; Sawyer, S.S.; Nealeigh, R.C. Aug 1978.

In CSU—FDA collaborative radiological health laboratory annual report, 1977.

Renal function testing of irradiated and unirradiated beagles at CRHL has been carried out for the past 7 years using a simultaneous estimation of sodium sulfanilate and sodium iodohippurate ^{131}I clearance. Evidence has been cited that the beagle kidney is markedly sensitive to whole-body ionizing radiation delivered in the perinatal period. The objectives of this continuing study are to determine the nature of the progression of chronic renal disease, its possible association to hypertension, the impact of unilateral nephrectomy upon an already compromised renal parenchyma, and the age-related changes in renal function. Thus far, data seem to indicate the following conclusions: sulfanilate clearance appears to be a sensitive indicator of impending renal failure, exhibiting earlier and more obvious indicators than BUN (blood urea nitrogen) levels; hypertension does not appear to be a factor in radiation-induced renal failure in the adult dogs studied here, since the average arterial blood pressure was as high in normal control dogs as in irradiated dogs suffering from renal failure; unilateral nephrectomy affected unirradiated dogs less than irradiated animals with mild renal insufficiency. The BUN levels returned to prenephrectomy levels in 8 weeks in the unirradiated group, but required up to 1 year in the dogs with renal insufficiency; and an age related decrease inrenal function was observed in a group of unirradiated dogs studied from 0 to 2 through 13 years of age.

41752 (UCRL—81774) **New radiobiological findings bearing on the 1977 ICRP recommendations.** Dobson, R.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Feb 1979. Contract W-7405-ENG-48. 17p. (CONF-790316—1). Dep. NTIS, PC A02/MF A01.

From Topical seminar on the practical implications of the ICRP recommendation and the revised IAEA basic standards for radiation protection; Vienna, Austria (5 Mar 1979).

Recent experiments on low-level irradiation during development raise questions relevant to ICRP Publication 26. Mice and monkeys were studied; the measured endpoint was the radiation-induced loss of female germ cells. Three issues are examined. The first is the numerical value of Q (quality factor) appropriate for low-energy beta rays. Comparisons of tritium with gamma radiation were made under conditions of chronic, low-level exposure, and the relative biological effectiveness (RBE) was found to approach 3. Its bearing on ICRP's recommendations concerning Q applicable to tritium is discussed. Second, female germ cells in squirrel monkeys before birth were discovered to be extraordinarily radiosensitive, more easily destroyed than those of mice. If this holds for other primates too, it has radiation-protection implications hitherto overlooked. Third, the contrast between massive germ-cell loss from chronic exposure in prenatal squirrel monkeys and reported radioresistance of oocytes to acute exposure in rhesus monkeys, unless due to species difference, suggests that during development protracted irradiation may be especially injurious. This also could have important radiation-protection implications and is under investigation. (ERB)

41753 (UR—3490-1607) **Study on the induction of thyroid tumors in rats using x irradiation in conjunction with a goitrogen.** Mahler, P. (Rochester Univ., NY (USA). Dept. of Radiation Biology and Biophysics; Rochester Univ., NY (USA). School of Medicine and Dentistry). 1979. Contract EY-76-C-02-3490. 196p. Dep. NTIS, PC A09/MF A01.

Thesis.

The influence of acute localized thyroid x irradiation and chronic goitrogen administration, separately or combined, on thyroid tumor formation in mature female rats was studied. In the first experiment, the radiation doses were 0, 80, 160, 320, or 640 rads, and the dosages of goitrogen were 0, 4, or 40 parts per million (ppM) of 1 methyl - 2 mercaptoimidazole (MMI). The incidence of rats with thyroid tumors in any treated group receiving 0 or 4 ppM MMI was not significantly greater than the incidence in the nontreated control group. However, the incidence in any of the 40 ppM MMI groups was significantly greater than that in the nontreated control group. At all the radiation doses other than 80 rads, the incidence was significantly greater than that in the non-irradiated group. No significant difference was seen in the incidence of rats with thyroid tumors on the basis of radiation dose. The incidence was so high at 80 rads that there was little margin for further increase by increasing the radiation dose. The mean serum thyroxine levels at 40 ppM MMI, 4 ppM MMI, and 0 ppM MMI were 1.9, 3.5, and 3.7 μg/100 ml, respectively. No markedeffect of thyroid irradiation on mean serum thyroxine levels was seen. In the second experiment, rats receiving 200 ppM MMI and thyroid irradiation were sacrificed at 7-1/2

months after treatment. Nearly all rats in the 0 and 80 rad groups and all in the 160, the 320, and the 640 rad groups had thyroid tumors. In the third experiment, serum T_4 levels were measured in treated rats. Rats receiving 640 rads + 0 ppM MMI showed a slight decrease in serum T_4, while no change in serum T_4 levels was seen in rats receiving 0 rads + 4 ppM MMI or 640 rads + 4 ppM MMI. All rats receiving 40 ppM MMI, regardless of radiation dose, showed decreased serum T_4 levels.

MAN

REFER ALSO TO CITATION(S) 41634, 41635, 41735

NUCLIDE KINETICS AND TOXICOLOGY

MAN

REFER ALSO TO CITATION(S) 40456, 41626, 41643

41754 (PNL—2850(Pt.5), pp 4.0-4.5) **Human health studies.** Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 5. Environmental assessment, control, health and safety.

Results of statistical health effect studies to assess the influence of low-level exposure to environmental contaminants and the analysis of urine for heavy metals and DTPA salts are summarized briefly. Analyses were conducted on urine samples from a person accidentally contaminated with ^{241}Am and treated intravenously with DTPA salts to promote the americium's excretion. Assays for essential body metals and DTPA species are of particular concern. Preliminary results are presented. (JGB)

ANIMALS

REFER ALSO TO CITATION(S) 41650

41755 (EMSL-LV—0539-23) **Biological transport of curium-243 in dairy animals.** Sutton, W.W.; Patzer, R.G.; Hahn, P.B.; Potter, G.D. (Environmental Protection Agency, Las Vegas, NV (USA). Environmental Monitoring and Support Lab.). Apr 1979. Contract EY-76-A-08-0539. 27p. Dep. NTIS, PC A03/MF A01.

Lactating cows and goats were used to examine the biological transport of curium-243 in dairy animals. After either single oral or intravenous nuclide doses were administered, samples of milk, urine, blood, and feces were taken over a 144-hr priod, and the curium concentrations were determined by gamma counting. Gastrointestinal uptake of curium was estimated to be 0.02 and 0.006% of the oral dose for cows and goats, respectively. The cumulative percentage of oral dose transported to milk and urine was 4.6×10^{-4} and 1.9×10^{-3}, respectively, for a cow and 2.7×10^{-4} and 1.6×10^{-4}, respectively, for goats. Plasma concentrations of curium decreased rapidly following all intravenous injections. The average percentage of injected curium transferred to milk, urine, and feces was 2, 8, and 1, respectively, for a cow and 2, 5, and 5, respectively, for goats. All animals were sacrificed one week after dosing. Bovine bone retained the greatest fraction of the administered dose and the next highest was the liver. However, in all three intravenously dosed goats the liver contained the greatest amount of curium. Nuclide deposition in bone and liver was essentially equal for two of the three orally dosed goats while the skeleton contained the most curium in the other animal. Comparisons are presented between curium-243 and americium-241 transport in dairy cows.

PLANTS

REFER ALSO TO CITATION(S) 41652

41756 (DP—1489, pp 111-113) **Plutonium sorption by the green algae Scenedesmus obliquus (Tuerp) Kuetz.** Tkacik, M.F.; Giesy, J.P.; Corey, J.C. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

As part of the continuing study of the possible impact of released radioisotopes to the Savannah River Plant (SRP) environment, the interaction between a biological system and plutonium was investigated. Specifically, an algal culture, Scenedesmus obliquus, was exposed to the +4 and +6 oxidation states of ^{238}Pu and $^{239-240}Pu$ at three plutonium concentration levels. There was no significant different (p 3) 0.05) between ^{238}Pu and $^{239-240}Pu$ accumulation by the algae at equivalent concentrations or at different oxidation states.

THERMAL EFFECTS

MICROORGANISMS

REFER ALSO TO CITATION(S) 41757

INVERTEBRATES

41757 (NUREG/CR—0634) **Analysis of populations of boring and fouling organisms in the vicinity of Oyster Creek Nuclear Generating Station. Annual progress report, September 1, 1977—August 31, 1978.** Hoagland, K.E.; Crocket, L. (Lehigh Univ., Stone Harbor, NJ (USA). Wetlands Inst.). Dec 1978. 126p. Dep. NTIS, PC A07/MF A01.

The growth, distribution, and species composition of marine borers (primarily shipworms) and fouling organisms were studied in the vicinity of the Oyster Creek Nuclear Generating Station. This report presents data on the relationship between the Generating Station and sedentary marine organisms, especially shipworms. A review and interpretation of the data for the period May 27, 1977—August 31, 1978, in the context of results since 1971 are given. A shipworm outbreak has again occurred in Oyster Creek. The overwhelmingly dominant species is Teredo bartschi, but a few T. navalis, B. gouldi, and T. furcifera were also found. The first sign of an outbreak of T. bartschi came in early spring, 1978, but by August, panels in Oyster Creek were riddled. The 1978 outbreak differs from the one that occurred soon after the Generating Station began operation, in that the earlier outbreak consisted of the endemic species Bankia gouldi and Teredo navalis. Dominant species of fouling organisms change on a monthly basis, but repeat on a seasonal basis. Some fouling organisms such as Limnoria may interfere with shipworm settlement.

CHEMICALS METABOLISM AND TOXICITY

REFER ALSO TO CITATION(S) 42144

CELLS

41758 (CONF-790227—1) **Use of short-term tests for mutagenicity and unscheduled DNA synthesis in intact mammals.** Cumming, R.B. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 7p. Dep. NTIS, PC A02/MF A01.

From International workshop on short-term tests for prescreening of potential carcinogens; Genoa, Italy (6 Feb 1979).

In vivo test systems were developed that are relatively rapid and give quantitative data with relatively few animals and retain many of the advantages of testing in intact animals. The use of the test for unscheduled DNA synthesis in male germ cells of mice is described. (HLW)

41759 (CONF-790227—2) **Induction of mutagenesis and alterations in gene expression by tumorigenic chemicals.** Huberman, E. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 16p. Dep. NTIS, PC A02/MF A01.

From International workshop on short-term tests for prescreening of potential carcinogens; Genoa, Italy (6 Feb 1979).

To determine the relationship between mutagenesis and carcinogenesis, a series of eleven polycyclic hydrocarbons with different degrees of carcinogenicity were tested in the cell-mediated mutagenesis assay for the induction of ouabain-resistant mutants. Four carcinogenic hydrocarbons induced ouabain-resistant mutants; five noncarcinogenic hydrocarbons were not mutagenic. Results indicated that there was a relationship between mutagenesis and the degree of carcinogenicity of polycyclic hydrocarbons after enhancement of their metabolism by aminophylline. To study liver carcinogens a system was developed for cocultivating primary liver cells and V79 hamster cells. In this system the nitrosamines and aflatoxins were metabolized by liver cells to intermediates that were mutagenic to the V79 cells. In experiments using human cells, tumor-promoting phorbol esters induced terminal differentiation while in other studies, in which avian and murine cells were employed, they inhibited differentiation. The results imply that human cells may respond differently from mouse and chicken cells to the biological effects of phorbol diesters. (HLW)

MICROORGANISMS

REFER ALSO TO CITATION(S) 41757

PLANTS

41760 (COO—4368-1) **Effects of sulfur dioxide and nitrogen dioxide on vegetation. Progress report, 1 June 1977—28 February 1978.** Weinstein, L.H.; McCune, D.C.; MacLean, D.C. (Boyce

Thompson Inst. for Plant Research, Inc., Yonkers, NY (USA)). Feb 1978. Contract EE-77-S-02-4368. 30p. Dep. NTIS, PC A03/MF A01.

The areas of research selected are related to fossil fuel combustion and are believed or are known to occur in the field: the mode of action of SO_2 in relation to its metabolic fate; the influence of NO_2 on the phytotoxicity of SO_2, and the combined effects of these pollutants on crop yield under field conditions; the effect of SO_2 on the plant with respect to its susceptibility to plant diseases; and the effect of SO_2 on the behavior and development of the Mexican bean beetle on soybean and on the production of volatile terpenoids in conifers with respect to their suitability for colonization by insects.

41761 (COO—4368-2) **Effects of sulfur dioxide and nitrogen dioxide on vegetation. Progress report, 1 June—30 September 1978.** Weinstein, L.H.; McCune, D.C.; MacLean, D.C. (Boyce Thompson Inst. for Plant Research Ithaca, NY (USA)). Jan 1979. Contract EE-77-S-02-4368. 9p. Dep. NTIS, PC A02/MF A01.

Progress is reported on the following research projects: effects of NO_2 on the phytotoxicity of SO_2; interactions of air pollutants, plants, and plant pathogens; effects of SO_2 on plant-insect interactions; and mode of action and metabolism of SO_2 in plants. (HLW)

INVERTEBRATES

REFER ALSO TO CITATION(S) 41757

41762 (PNL—2931) **Biocide by-products in aquatic environments. Quarterly progress report, October 1—December 31, 1978.** Anderson, D.R.; Bean, R.M.; Gibson, C.I. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Mar 1979. Contract EY-76-C-06-1830. 45p. Dep. NTIS, PC A03/MF A01.

Analysis of water samples from several locations across the U.S. is underway. We have completed analysis using the Purge and Trap and headspace techniques on several locations. In the freshwater phase of the program we have completed fifteen chloroform acute toxicity bioassays with rainbow trout (Salmo gairdneri), bluegill (Lepomis macrochirus), and catfish (Ictalurus punctatus). Results indicate, in all cases, the LC-50 is well above that which could be expected to be discharged due to power plant chlorination. The LC-50's range from about 15 to 50 ppm chloroform depending on the species. Histological analysis is underway on clams from long-term chlorination by-product exposures. If the results of the histological analysis indicate an effect, further histological examination of samples from other concentrations will be conducted.

VERTEBRATES

REFER ALSO TO CITATION(S) 40106, 40338, 41753, 41762

41763 (CONF-790447—2) **Chemical and biological factors influencing the skin carcinogenicity of fossil liquids.** Holland, J.M.; Whitaker, M.J.; Gipson, L.C. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 29p. Dep. NTIS, PC A03/MF A01.

From Health implications of the new energy technologies; Park City, UT, USA (4 Apr 1979).

Synthetically derived petroleums, obtained from either oil shale or coal, are carcinogenic when applied to mouse skin. The fluorescence of these materials in sebaceous glands has been quantitated using microphotometry. Structural and compositional features of the skin may contribute to determine the localization and subsequent tissue clearance of carcinogenic hydrocarbons. The sebaceous gland and associated lipids have been demonstrated to serve as traps for PAH's and the relative amount of PAH deposited in sebaceous glands is significantly affected by the lipotropic nature of the vehicle. These observations are highly relevant to an assessment of the potential consequences of human occupational skin exposure to whole, undiluted hydrocarbon mixtures which may contain a variety of known carcinogenic PAH's. It is possible that short chain aliphatic and aromatic molecules which make up the bulk of the syncrude may have as great or greater impact upon delayed or cumulative biological effects as the relative amount of specific active compounds.

41764 (COO—4800-4) **Effects of chemical carcinogens of hemopoiesis, immunopoiesis and viral oncogenesis. Technical progress report, December 1, 1977—September 30, 1978.** OKunewick, J.P.; Raikow, R.B.; Meredith, R.F. (Allegheny General Hospital, Pittsburgh, PA (USA). Cancer Research Unit). Oct 1978. Contract EP-78-S-02-4800. 93p. Dep. NTIS, PC A05/MF A01.

During the past year we have concentrated on defining the circumstances under which methyl methanesulfonate (MMS), benzo[a] pyrene (BP), and 7,12-dimethylbenz[a]anthracene (DMBA) interact with Friend virus (FLV) to produce leukemia. The optimum scheduling for each and also the effective dose levels of the chemicals have been partially determined. There are at least three critical factors which govern whether or not a leukemogenic interaction can be shown between the chemical agents and the virus. These are chemical dose, virus dose, and their relative time of administration. The most critical of these is virus dose. The optimum virus dose is that which results in between 25 and 40% incidence of leukemia within 40 days after virus infection when virus is given alone. The chemical carcinogens have a lower dose threshold, below which no significant potentiating effect can be observed. The only upper limit would appear to be acute drug toxicity. The third element, timing, is equally critical and varies according to the chemical. This variation may reflect different mechanisms of action by the chemical agents and/or different pharmacology. Data on the effects of MMS, BP, and DMBA on the immune system have indicated that the viral enhancement is probably not dependent on this function. Further enhancement of the potentiation of viral leukemogenesis was observed using benzo[a]pyrene and caffeine, indicating that the inhibition by caffeine of DNA repair may be an important factor in virus potentiation. (ERB)

MAN

REFER ALSO TO CITATION(S) 41763

41765 (BNL—25707) **Critical concentrations of cadmium in human liver and kidney measured by prompt-gamma neutron activation.** Cohn, S.H.; Vartsky, D.; Yasumura, S.; Zanzi, I.; Ellis, K.J. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 16p. (CONF-790225—1). Dep. NTIS, PC A02/MF A01.

From International cadmium conference; Cannes, France (6 Feb 1979).

Few data exist on Cd metabolism in human beings. In particular, data are needed on the role of parameters such as age, sex, weight, diet, smoking habits, and state of health. Prompt-gamma neutron activation analysis (PGNAA) provides the only currently available means for measuring in vivo levels of liver and kidney Cd. The method employs an 85 Ci, ^{238}Pu,Be neutron source and a gamma ray detection system consisting of two Ge(Li) detector. The dose delivered to the liver and left kidney is 666 mrem (detection limit is 1.4 μg/g Cd in the liver and 2.0 mg Cd for one kidney). Absolute levels of Cd in the kidney and concentrations of Cd in the liver were measured in vivo in twenty healthy adult males using ^{238}Pu,Be neutron sources. Organ Cd levels of smokers were significantly elevated above those of nonsmokers. Biological half-time for Cd in the body was estimated to be 15.7 yr. Cigarette smoking was estimated to result in the absorption of 1.9 μg of Cd per pack. No relationship was bound between body stores of Cd (liver and kidney) and Cd or β-microglobulin levels in urine and blood. Currently the above neutron activation facility is being mounted on a 34-ft mobile trailer unit. This unit will be used to monitor levels of Cd in industrial workers. It is anticipated that critically important data, particularly on industrially exposed workers, will provide a better basis for determining critical concentrations and for the setting or revision of standards for industrial and environmental Cd pollution. (ERB)

41766 (ORNL/EIS—149) **Cadmium in foods: a review of the world's literature.** Drury, J.S.; Hammons, A.S. (Oak Ridge National Lab., TN (USA)). Feb 1979. Contract W-7405-ENG-26. 307p. (EPA—560/2-78-007). Dep. NTIS, PC A14/MF A01.

This document tabulates detailed information obtained from 151 references for most of the original measurements of cadmium in foods published since 1940 and summarizes estimates of dietary intake of cadmium in the United States and foreign countries. Cadmium concentrations are indicated for about 1500 individual foods listed alphabetically and by decreasing concentration within typical food categories. Separate compilations are provided for foods originating in contaminated and uncontaminated areas for domestic and foreign products. Most foods contained low concentrations of cadmium, generally less than 0.050 mg/kg, wet weight. Concentrations of cadmium were greatest in shellfish, leafy vegetables, potatoes, grain and cereal products, and selected animal organs, particularly kidneys and liver. The use of cadmium-containing phosphate fertilizers increased the concentration of cadmium in some, but not all, plant foods. Diets chosen exclusively from foods produced near point sources, or from highly contaminated soils, put users at great risk of exceeding recommended intake levels. No clear pattern of concentration differences could be discerned in foods produced in areas distant from point sources. Although annual increases of cadmium in successive crops of certain plant foods were documented, no temporal trend of increasing cadmium concentrations in food is apparent in the tabulated data, nor is there a perceptible increase in the cadmium content of foods due to canning or other food-processing operations. Estimates of dietary intake of cadmium vary widely.

Based on the tabulated data, the average daily U.S. dietary intake appears to lie within the range 30 to 50 μg.

OTHER ENVIRONMENTAL POLLUTANT EFFECTS

41767 (AD-A—060299) **The effect of laser energy on cells in tissue culture. Report No. 6 (final), 1963—1976.** Rounds, D.E. (Pasadena Foundation for Medical Research, CA (USA)). May 1978. Contract DA-49-193-MD-2564. 32p. NTIS PC A03/MF A01.

The first area reported that energy-dependent biological systems, such as mitosis and contractile activity of heart, skeletal muscle and smooth muscle tissues, showed a temporary (and sometimes permanent) reduction in activity when irradiated with a ruby laser. Evidence for another indirect form of biological damage stemmed from the observation that ruby laser irradiation of cells in tissue culture depleted the population of intact lysosomes and released a mixture of amino acids, nucleosides and nucleotides. Studies utilizing a variety of laser wavelengths illustrated the requirement for absorbing laser energy in natural or artificial chromophores before biological effects could be produced. Pigmented cells were damaged by ruby laser treatment in proportion to the number of melanin granules per cell.

41768 (JPRS—72606) **Translations on USSR Science and Technology: Biomedical and Behavioral Sciences, No. 53. Effects of nonionizing electromagnetic radiation.** 12 Jan 1979. Translation of various articles. 57p. NTIS.

The report contains information on aerospace medicine, agrotechnology, bionics and bioacoustics, biochemistry, biophysics, environmental and ecological problems, food technology, microbiology, epidemiology and immunology, marine biology, military medicine, physiology, public health, toxicology, radiobiology, veterinary medicine, behavioral science, human engineering, psychology, psychiatry and related fields, and scientists and scientific organizations in biomedical fields.

GEOSCIENCES

REFER ALSO TO CITATION(S) 41631, 41632

41769 (DP—1489, pp 171-178) **Comparison of stability categories obtained from an acoustic sounder with those obtained from conventional meteorological data.** Pendergast, M.M.; Schubert, J.F. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

Acoustic sounder categories were tested as a means of indicating atmospheric stability. A preliminary analysis has shown that none of the existing acoustic categories is unambiguously correlated with atmospheric stability. The category showing the most consistent relationship with stability is Category 14, which corresponds to stable conditions for all periods except windy days. The above conclusions indicate that acoustic categories do not correlate very well with other methods for determining atmospheric stability on an hour-for-hour basis. In examing these results, one must be aware that Pasquill class, $\delta T/\delta z$, and δphi do not produce similar estimates of stability conditions for a specific one-hour period. The above three methods do produce frequency distributions of the three stability conditions within about 10 percent over long periods such as a year.

41770 (DP—1489, pp 179-186) **Acoustic detection of momentum transfer during the abrupt transition from a laminar to a turbulent atmospheric boundary layer.** Schubert, J.F. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The acoustic sounder provides a graphic means of monitoring in real-time the transition of the atmospheric boundary layer from one state or condition to another state or condition. Until recently, these transiton periods were inferred from data obtained using meteorological towers with the usual restrictions of height and widely separated measurements. The acoustic sounder presents the investigator with a continuous profile of the boundary layer between ground level and heights well above most towers. The abrupt transition from the laminar flow to a turbulent flow as observed on June 8, 1975, does not appear to be a unique case; the records indicate that it is probably a common phenomenon. The essential characteristics are clear sky in the preceding afternoon and evening, little or no surface mixing prior to the transition, rapid surface cooling after sundown, and moderate wind shear with height. Turbulent mixing is the mechanism for the breakdown of the laminar flow, but the triggering mechanism is not clearly evident from the sounder records. The triggering could possibly be brought about by the Kelvin-Helmholtz instabilities between the layers. These instabilities create regions of intense shear in the inner layer, or a liftup or up-welling from an adverse pressure gradient caused by horizontal roll vortices.

41771 (DP—1489, pp 187-190) **Pollutant forecasting error based on persistence of wind direction.** Cooper, R.E. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The purpose of this report is to provide a means of estimating the reliability of forecasts of downwind pollutant concentrations from atmospheric puff releases. These forecasts are based on assuming the persistence of wind direction as determined at the time of release. This initial forecast will be used to deploy survey teams, to predict population centers that may be affected, and to estimate the amount of time available for emergency response. Reliability of forecasting is evaluated by developing a cumulative probability distribution of error as a function of lapsed time following an assumed release. The cumulative error is determined by comparing the forecast pollutant concentration with the concentration measured by sampling along the real-time meteorological trajectory. It may be concluded that the assumption of meteorological persistence for emergency response is not very good for periods longer than 3 hours. Even within this period, the possibiity for large error exists due to wind direction shifts. These shifts could affect population areas totally different from those areas first indicated.

41772 (DP—1489, pp 191-194) **Calculating wind profiles above a pine forest.** Murphy, C.E.; Dexter, A.H. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

A major part of the environmental transport work at the Savannah River Laboratory (SRL) involves the dispersion of airborne pollutants (aerosols and gases). A major part of the Savannah River Plant (SRP) site is covered with pine forests. Because forests are "rough" surfaces which increase turbulence and surface shear stress and, hence, alter the dispersion patterns, the nature of the wind profiles above the forests is being investigated. Two methods for determining the surface shear caused by the atmospheric wind field over a pine plantation were compared. Friction velocity [the square root of the ratio of shearing stress over the density of air; U/sub */ = (stress/density)1/2] calculated by eddy correlation was compared with friction velocity calculated from wind profiles. Data from the first five meters above the pine forest were compared. The data indicated that there was no significant difference in the mean friction velocity measured by each method. However, there were large differences in individual values calculated by the two methods for many of the measurement periods. An attempt was made to reconcile the differences in the measured values, but no satisfactory method was found.

GEOLOGY AND HYDROLOGY

REFER ALSO TO CITATION(S) 40342, 40432, 41688

41773 (LBL—8571) **Observations of a potential size-effect in experimental determination of the hydraulic properties of fractures.** Witherspoon, P.A.; Amick, C.H.; Gale, J.E.; Iwai, K. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1979. Contract W-7405-ENG-48. 21p. (SAC—17). Dep. NTIS, PC A02/MF A01.

In several recent investigations, experimental studies on the effect of normal stress on the hydraulic conductivity of a single fracture were made on three rock specimens ranging in cross-sectional area from 0.02 m^2 to over 1.0 m^2. At the maximum stress levels that could be attained (10 to 20 MPa), minimum values of the fracture hydraulic conductivity were not the same for each rock specimen. These minimum values increased with specimen size, indicating that the determination of fracture conductivity may be significantly influenced by a size effect. The implications of these results are important. Cores collected in the field are normally not larger than 0.15 m in diameter. However, the results of this work suggest that when this size core is used for laboratory investigations, the results may be nonconservative in that fracture permeabilities will be significantly lower than will be found in the field. 6 figures.

41774 (UCRL—52556) **Numerical simulation of material transport in a regional ground-water flow system.** Naymik, T.G.; Thorson, L.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 31 Dec 1978. Contract W-7405-ENG-48. 29p. Dep. NTIS, PC A03/MF A01.

A numerical model of a regional ground-water flow system (not site specific) was coupled with a material transport model in order to study the influence of porosity and distribution coefficients in bedded media. The effects on model performance were discerned

from long-term material transport simulations. Model performance was based on initial breakthrough time, average breakthrough time, and the standard deviation of the breakthrough curve at a discharge surface. Large differences in model performance occurred when the distribution coefficient was changed less than an order of magnitude, while small differences resulted from changing porosity several orders of magnitude.

GEOPHYSICS

SEISMOLOGY AND TECTONICS

REFER ALSO TO CITATION(S) 40685

41775 (DP—1489, pp 73-79) **SRP seismography network operations August 6, 1976, to August 31, 1977.** Krapp, C.W.; Stephenson, D.E. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The Savannah River Plant (SRP) Seismograph Network is completed one year of nearly continuous operation and recorded 25 local earthquakes and more than 100 teleseisms. A large magnitude (M/sub s/=8) teleseism with the epicenter in the Indian Ocean, was recorded at SRP and is shown with some of the phases identified. An apparent seismic event is discussed which is attributed to shock wave-atmospheric interaction caused by a supersonic aircraft.

41776 (PB—288414) **An integrated geophysical and geological study of the tectonic framework of the 38th Parallel Lineament in the vicinity of its intersection with the extension of the New Madrid Fault Zone. Geotechnical report.** Braile, L.W.; Hinze, J.H.; Keller, G.R.; Lidiak, E.G. (Purdue Univ., Lafayette, IN (USA). Dept. of Geosciences). Sep 1978. Contract AT(49-24)-0323. 72p. NTIS PC A04/MF A01.

Extensive gravity and aeromagnetic surveys have been conducted in critical areas of Kentucky, Illinois, and Indiana centering around the intersection of the 38th Parallel Lineament and the extension of the New Madrid Fault Zone. Available aeromagnetic maps have been digitized and these data have been processed by a suite of computer programs developed for this purpose. Seismic equipment has been prepared for crustal seismic studies and a 150 km long seismic refraction line has been observed along the Wabash River Valley Fault System. Preliminary basement rock and configuration maps have been prepared based on studies of the samples derived from basement drill holes. Interpretation of these data are only at a preliminary stage, but studies to this date indicate that the 38th Parallel Lineament features extend as far north as 39 degrees N and a subtle northeasterly-striking magnetic and gravity anomaly cuts across Indiana from the southwest corner of the state, roughly on strike with the New Madrid Seismic Zone.

GEOPHYSICAL SURVEY METHODS

41777 **Correlation treatment of data from a combination of geophysical methods in differentiating mineral bodies.** Gevorkyan, V.M.; Kazaryan, S.S.; Trofimova, T.A. *Razved. Geofiz.;* No. 72, 139-143(1976). (In Russian).

A method is described for interpreting a combination of physical methods. As weighted coefficients a selection is made of particular vectors which correspond to a particular maximum value of a correlation matrix. A practical example is presented to show that it is possible to use this method in interpreting data from a combination of underground geophysical methods.

MINERALOGY, PETROLOGY, AND ROCK MECHANICS

REFER ALSO TO CITATION(S) 40429, 40771

41778 (DP—1489, pp 57-60) **Geohydrology of deposits of Claiborne age at the Savannah River Plant.** Marine, I.W.; Root, R.W. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

Previous usage of the term McBean Formation at the Savannah River Plant (SRP) included all deposits of Claiborne age (a time subdivision of the Eocene Epoch). The previous usage designated the McBean Formation as an aquifer capable of producing up to 3592 m^3/day (660 gallons per minute). Subsequent studies divided the deposits of Claiborne age in the SRP area into the McBean Formation (restricted), the Warley Hill Marl, and the Congaree Formation. Pumping tests at SRP indicate that the Congaree Formation is about 10 times more permeable than the McBean Formation (restricted). Because usage of the term McBean Formation to designate two differently defined formations and because there are calcareous solution cavities in the McBean Formation (restricted), it was commonly believed that the McBean Formation (restricted) was an aquifer. Although some water can be obtained from the McBean Formation (restricted), the principal aquifer in the deposits of Claiborne age is the Congaree Formation.

41779 (DP—1489, pp 61-63) **Verification studies of GWHEAD, a computer code for determining the ground water heat with three-dimensional flow.** Root, R.W.; Beckmeyer, R.R. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

As part of a program at the Savannah River Laboratory (SRL) to study the potential movement of radioactive material in ground water, quantitative computer models for ground-water flow and for waste transport are being developed. The program is divided into two major parts. The first part is to define geohydrology and to simulate numerically the ground-water flow. The second part is to define the geochemical and hydrodynamic dispersive effects of the geologic materials and to simulate numerically the transport of contaminants via the ground water. This report documents the verification of the ground-water head computer code (GWHEAD). For the cases of pumping from leaky aquifers, unconfined aquifers, and for the case of spherical flow to a continuous point sink, GWHEAD calculates values of hydraulic head that compare favorably with exact analytical solutions applicable to these cases.

41780 (DP—1489, pp 65-68) **Water-level fluctuations in coastal plain sediments at SRP.** Root, R.W.; Marine, I.W. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

Water levels in wells in selected hydrostratigraphic horizons at the Savannah River plant (SRP) are measured monthly to monitor water-level fluctuations in these horizons. Graphs of water levels are presented for seven wells that are close to each other and vary in depth from 15 to 122 meters. These graphs show variations of water level with time, depth of well, and precipitation. The fluctuations of water level are dampened with incresing depth and with separation from the surface by several clay layers of low permeability.

41781 (DP—1489, pp 69-71) **Summary of exploration drilling in F area for hydrogeologic information.** Root, R.W. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The Environmental Transport Division (ETD) of the Savannah River Laboratory (SRL) is developing a mathematical model of three-dimensional ground-water flow beneth the Separations Areas at the Savannah River Plant (SRP). This model requires values of the hydraulic head and the hydraulic conductivity for specific parts of the subsurface. A conceptual geologic framework is also needed. These needs are fulfilled by analyzing undistrubed cores and continuous split-barrel samples of the subsurface material and by tests on permanent wells. This report presents information on 16 wells completed around 200-F Area as part of this study.

GEOCHEMISTRY

REFER ALSO TO CITATION(S) 41627, 41660, 41661, 41662, 41679, 41690, 41691, 41692, 41693

41782 (DP—1489, pp 53-56) **Dependence of osmotic pressure on solution properties.** Fritz, S.J. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

Hydrostatic pressure, temperature, salt concentration, and the chemical composition of the salt are parameters affecting solution properties. Pressure and temperature have little effect on osmosis, but osmotic pressure variations due to type of dissolved salt may be significant, especially at high concentrations. For a given salt solution, concentration variations cause large differences in osmotic pressure. A representative difference in concentration across a clay layer in a relatively shallow groundwater system might be 100 to 1,000 ppm. When expressed as ppm NaCl, this difference could cause a head difference of 0.8 to 8 meters of water if one of the rock bodies were closed to fluid escape.

OCEANOGRAPHY

REFER ALSO TO CITATION(S) 41584, 41653, 41655, 41657, 41659, 41663, 41666, 41680, 41683, 41686, 41687, 41689

41783 (DOE/EV—00889-5) **Continental shelf processes affecting the oceanography of the South Atlantic Bight. Progress report,**

June 1, 1978—May 31, 1979. Atkinson, L.P. (Skidaway Inst. of Oceanography, Savannah, GA (USA)). Mar 1979. Contract EY-76-S-09-0889. 38p. Dep. NTIS, PC A03/MF A01.

Progress is reported on the following research projects: nitrogen inputs to the South Atlantic Bight; eddy experiments for obtaining quasi-synoptic map of South Atlantic Bight; cruise experiment for observation of stranded intrusion in the South Atlantic Bight; geographic distribution of hydrographic data; and computer plotting and contouring of data. (HLW)

41784 Carbonate sediments on the flanks of seamount chains. Winterer, E.L. (Scripps Institution of Oceanography, La Jolla, CA). pp 693-715 of Fate of fossil fuel CO_2 in the oceans. Andersen, N.R.; Malahoff, A. (eds.). New York; Plenum Press (1977).

From Symposium on the fate of fossil fuel CO2 in the oceans; Honolulu, HI, USA (16 Jan 1976).

The summits and flanks of seamount chains, aseismic ridges, and oceanic plateaus are good storage areas for carbonate sediments of a wide range of depth facies. Drill data suggest that except for seamounts in their very youthful stage, which have special rates and special sedimentary facies, subsidence of these regions may be similar to that of normal oceanic lithosphere, and that the methods of plate stratigraphy could be applied to their sedimentary record.

PHYSICS RESEARCH

41785 Mathematical problems in theoretical physics. Dell'Antonio, G.; Doplicher, S.; Jona-Lasinio, G. (eds.). Berlin, Germany; Springer (1978). vp. (CONF-7706174—).

From International conference on the mathematical problems in theoretical physics; Rome, Italy (6 Jun 1977).

A PDFD will operate in the 1980's and must provide the plasma and plasma support technology information necessary to warrant design, construction, and operation of succeeding experimental power reactors and then the demonstration plant. The PDFD must be prototypical of economic fusion devices to justify its cost. Therefore, development of the fusion core will be the focus of the PDFD. The physics performance, power production objectives, and characteristics of the PDFD, and their relationship to the research and development needs to achieve them are outlined. The design criteria for a PDFD which satisfied these constraints will be established.

ASTROPHYSICS AND COSMOLOGY

COSMIC RADIATION

41786 (LBL—8799) **Cosmic microwave background: present status and future prospects.** Muller, R.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1978. Contract W-7405-ENG-48. 18p. (CONF-781245—1). Dep. NTIS, PC A02/MF A01.

From 13. Texas conference on relativistic astrophysics; Munich, F.R. Germany (14 Dec 1978).

After a brief review of the origin of the radiation according to the standard model, the status of present measurements of the spectrum and the large-scale isotropy is discussed. Finally, it is indicated what are the prospects for improved measurements in the next decade. 17 references. (JFP)

41787 Spectrum of the cosmic background radiation. Woody, D.P.; Richards, P.L. (Department of Physics, University of California, and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, Berkeley, California 94720). *Phys. Rev. Lett.;* 42: No. 14, 925-929(2 Apr 1979).

New measurements of the emission spectrum of the night sky have been made in the frequency range from 1.7 to 40 cm^{-1} using a fully calibrated, liquid-helium—cooled, balloon-borne spectrophotometer. The results show that the spectrum of the cosmic background radiation peaks at 6 cm^{-1} and is approximately that of a 3-K blackbody out to several times that frequency. However, the data show deviations from a simple blackbody curve.

SOLAR PHENOMENA

REFER ALSO TO CITATION(S) 41791, 41792

41788 (N—78-31032) **Time delay occultation data of the Helios spacecraft for probing the electron density distribution in the solar corona. Final report.** Edenhofer, P.; Lueneburg, E.; Esposito, P.B.; Martin, W.L.; Zygielbaum, A.I. (Jet Propulsion Lab., Pasadena, CA (USA)). Aug 1978. 48p. NTIS PC A03/MF A01.

S-band time delay measurements were collected from the spacecraft Helios A and B during three solar occultations in 1975/76 within heliocentric distances of about 3 and 215 earth radius in terms of range, Doppler frequency shift, and electron content. Characteristic features of measurement and data processing are described. Typical data sets are discussed to probe the electron density distribution near the sun (west and east limb as well) including the outer and extended corona. Steady-state and dynamical aspects of the solar corona are presented and compared with earth-bound-K-coronagraph measurements. By use of a weighted least-squares estimation, parameters of an average coronal electron density profile are derived in a preliminary analysis to yield electron densities at r = 3, 65, 215 earth radii. Transient phenomena are discussed and a velocity of propagation v is nearly equal to 900 km/s is determined for plasma ejecta from a solar flare observed during an extraordinary set of Helios B electron content measurements.

41789 Association of low-frequency waves with suprathermal ions in the upstream solar wind. Paschmann, G.; Sckopke, N.; Bame, S.J.; Asbridge, J.R.; Gosling, J.T.; Russell, C.T.; Greenstadt, E.W. (Max-Planck-Institut fuer Physik und Astrophysik, Institut fuer Extraterrestrische Physik, 8046 Garching, Germany). *Geophys. Res. Lett.;* 6: No. 3, 209-212(Mar 1979).

Observations obtained upstream of the earth's bowshock with the LASL/MPI plasma instruments and the UCLA magnetometers on ISEE-1 and 2 have revealed a striking relationship between the presence of low-frequency fluctuations in solar wind density and field strength and the different types of distribution functions of upstream ions. Waves are absent when the ions have the beamlike distribution of the "reflected" ions. Large-amplitude waves are present only in conjuction with the "diffuse" ions, which are characterized by flat energy spectra and broad angular distributions. The waves are largely compressive, showing very good correlation between oscillations in magnetic field strength and plasma density.

COSMOLOGY

41790 Light-element abundances, galactic evolution, and the universal baryon density. Mathews, G.J.; Viola, V.E. Jr. (Lawrence Berkeley Laboratory, University of California, Berkeley). *Astrophys. J.;* 228: No. 2, 375-378(1 Mar 1979).

It is demonstrated that by considering the abundance ratio of ^{7}Li to D, an upper limit to the universal baryon density, rho/sub b/, can be established which is largely independent of the degree to which these elements have been processed through stars. The sensitivity of the inferred limits to rho/sub b/, due to possible galactic or pregalactic sources of D or ^{7}Li, and unknown conditions during big-band nucleosynthesis, is also discussed.

PLANETARY PHENOMENA

41791 (N—78-31039) **Magnetic fields, plasmas, and coronal: the inner solar system.** Burlaga, L.F. (National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center). Jul 1978. 32p. NTIS PC A03/MF A01.

In situ magnetic field and plasma observations within 1 AU which describe MHD stream flows and Alfvenic fluctuations, and the latest theories of those phenomena, are discussed. Understanding of streams and fluctuations was enhanced by the acquisition of nearly complete sets of high-resolution plasma and magnetic data simultaneously at two or more points by IMPs 6, 7, and 8, Mariner-Venus-Mercury, HELIOS 1, and HELIOS 2. Observations demonstrate that streams can have very thin boundaries in latitude and longitude near the sun. This has necessitated a revision of earlier views of stream dynamics, for it is now clear that magnetic pressure is a major factor in the dynamics of stream in the inner solar system and that nonlinear phenomena are significant much closer to the sun than previously believed. Simultaneous IMP 6, 7, and 8 observations of Alfvenic fluctuations indicate that they are probably not simply transverse Alfven waves and suggest that Alfvenic fluctuations are better described as nonplanar, large-amplitude, general Alfven waves moving through an inhomogeneous and discontinuous medium, and coupled to a compressive mode.

41792 (N—79-10985) **Lunar magnetic permeability, magnetic fields, and electrical conductivity temperature. Final report, 1 September 1975—31 August 1978.** Parkin, C.W. (Santa Clara Univ., CA (USA). Dept. of Physics). 31 Aug 1978. 131p. NTIS PC A07/MF A01.

In the time period 1969-1972 a total of five magnetometers were deployed on the lunar surface during four Apollo missions. Data from these instruments, along with simultaneous measurements from other experiments on the moon and in lunar orbit, were used to study properties of the lunar interior and the lunar environment. The principal scientific results from analyses of the magnetic field data are discussed. The results are presented in the following main categories: (1) lunar electrical conductivity, temperature, and struc-

ture; (2) lunar magnetic permeability, iron abundance, and core size limits; (3) the local remnant magnetic fields, their interaction with the solar wind, and a thermoelectric generator model for their origin. Relevant publications and presented papers are listed.

ATMOSPHERIC PHYSICS

41793 Theoretical study of stratospheric trace species variations during a solar eclipse. Wuebbles, D.; Chang, J.S. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Geophys. Res. Lett.;* 6: No. 3, 179-182(Mar 1979).

A one-dimensional transport-kinetics model is used to examine the variations in stratospheric minor species concentrations expected to occur during an eclipse of the sun. The short chemical lifetime of some of the important stratospheric species suggest that significant variations in concentration of some species are expected. Species which show large diurnal behavior, such as NO and OH, should be expected to have especially noticeable changes during the eclipse. Such variations during an eclipse, if measured, could provide a validation for the short response time chemistry in several catalytic cycles currently used in models of stratospheric chemistry.

AURORAL AND IONOSPHERIC PHENOMENA

41794 (AD-A—059922) **Electron density structure in barium clouds — measurements and interpretation. Final report, 1 June 1976—28 February 1978.** Baker, K.D.; Ulwick, J.C.; Kelley, M.C.; Howlett, L.C.; Allred, G.D. (Utah State Univ., Logan (USA)). Feb 1978. Contract DNA001-76-C-0278. 101p. NTIS PC A06/MF A01.

Six instrumented rockets were used to probe three separate ion clouds that resulted from F-region barium releases, and measure electron density structure within the clouds. Two probes were launched into each of the three ion clouds, and each probe showed considerable enhancement in F-region electron density over the normal background levels. In four traversals the electron density exceeded 1,000,000/cu.cm. with a maximum of 5,000,000/cu.cm. observed in one case. Two showed dramatic structure in the electron density profiles associated with passage through striated portions of the cloud. These structures had spatial extent as measured by the rocket probes normal to the terrestrial magnetic field of hundreds of meters with the density changing by factors of from about 2 to 10 as the probes passed into and out of the structure. The change of density on some of the features had particularly fast drop off, corresponding to less than 20 meters travel normal to the magnetic field. (Author)

41795 Precipitation of fast electrons in an interaction with a plasma jet from a rocket in the ionosphere. Kapitanov, V.Y.; Mishin, E.V. (Institute of Geomagnetism, the Ionosphere, and Radio Wave Propagation, Academy of Sciences of the USSR). *Sov. J. Plasma Phys. (Engl. Transl.);* 4: No. 5, 628-630(Sep 1978).

The precipitation of electrons confined by the geomagnetic field due to scattering by lower hybrid waves excited by a plasma jet injected into the ionosphere is studied. The flux of precipitated electrons is found as a function of the injection altitude.

MAGNETOSPHERIC PHENOMENA

REFER ALSO TO CITATION(S) 42044

41796 Strong electron pitch angle diffusion observed at geostationary orbit. Baker, D.N.; Stauning, P.; Hones, E.W. Jr.; Higbie, P.R.; Belian, R.D. (University of California, Los Alamos Scientific Laboratory, Los Alamos, NM 87545). *Geophys. Res. Lett.;* 6: No. 3, 205-208(Mar 1979).

Comparison of auroral zone riometer data with high-resolution energetic electron data at the geosynchronous orbit confirms previous observations that significant electron (E> or $\approx$30 keV) precipitation begins remarkably near the flux level predicted in the Kennel-Petschek theory. The present new observations, however, also provide adequate pitch angle information to study the detailed evolution of energetic electron anisotropies from the weak pitch angle diffusion limit to the strong diffusion limit predicted in the theory of wave-particle interactions. Since all substorm-accelerated electrons which are injected after fluxes have reached the strong diffusion limit are rapidly scattered and lost from the magnetosphere, the present measurements provide a new experimental electron upper flux limit of 5 x 10^7 electrons $(cm^2\text{-sec-sr})^{-1}$ at L=6.6.

41797 (N—79-10269) **A set of satellite experiments for studying the magnetosphere-ionosphere communications.** Gringauz, K.I. (National Aeronautics and Space Administration, Washington, DC (USA)). Oct 1978. Translated from Kompleks Sputnikovykh Eksperimentov Diya Izucheniya Magnitosferno-Ionosfernykh Svyazey, 1976, p. 1-13. 13p. NTIS PC A02/MF A01.

Magnetospheric substorms are one of the basic problems in the physics of near-earth space. They appear as magnetic and ionospheric perturbations, disturbances in radio communication, polar auroras and electromagnetic radiation in different frequency ranges. These phenomena were studied from single satellites. However, it is impossible to study these phenomena adequately without simultaneous measurements from at least two different positions with identical instruments. A suitable program can be developed based on the Interkosmos work using new achievements in electronics.

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

BEAMS AND THEIR REACTIONS

41798 (COO—2753-103) **X-ray production and electron transfer cross sections for 0.4 to 2.2 MeV/amu N, O_2 and F ions on Al.** Gray, T.J.; Richard, P.; Gealy, G.; Newcomb, J.; Tawara, H. (Kansas State Univ., Manhattan (USA). Dept. of Physics). 1978. Contract EY-76-S-02-2753. 3p. (CONF-781113—37). Dep. NTIS, PC A02/MF A01.

From 5. conference on application of small accelerators; Denton, TX, USA (6 Nov 1978).

Measurements of the target K-ray production cross sections for N, O, and F ions on solid Al targets were performed as a function of projectile energy. The target x-ray yields were measured as functions of the Al target thickness. High resolution x-ray energy spectra were measured, and a typical spectrum is shown. These data were used to determine the average target fluorescence yield. 20 references. (JFP)

41799 (NRL-MR—3814) **Secondary electron emission by energetic ions incident on metal surfaces.** Decoste, R.; Ripin, B.H. (Naval Research Lab., Washington, DC (USA)). Aug 1978. Contract ES-77-A-01-6021. 15p. Dep. NTIS, PC A02/MF A01.

An experimental technique, especially well adapted to measure secondary electron coefficients for energetic ions incident on any charge collector surface, is described. The technique uses a laser-produced plasma as an ion source, a high-energy ion analyzer as an ion energy and species filter and a tubular electrode arrangement to suppress or attract the secondary electrons at the charge collectors. The secondary electron coefficients for several ionization states of carbon and hydrogen ions incident on copper surfaces are given as a function of incident ion energy between 15 and 150 keV/Z.

41800 (UCRL—13962) **Development of high current low energy H^+ ion source.** Forrester, A.T.; Crow, J.T.; Goebel, D.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1978. Contract W-7405-ENG-48. 20p. Dep. NTIS, PC A02/MF A01.

The ultimate goal of this work is the development of an ion source suitable for double charge exchange of D^+ ions to D^- ions in cesium or other vapor. Since the fraction of the D^+ which changes to D^- may be as high as 0.35 in the energy below one keV, the process appears very favorable. What is desired is a source of several hundred cm^2 area, with a D^+ current density greater than, say 0.2A/cm^2. Small angular spread is essential with up to about 0.1 radian being acceptable. A simple approach to this problem appears to be through fine mesh extraction electrodes. In this system a single grid facing the ion source plasma constitutes the entire extraction electrode system. If the potential difference between the grid and the source plasma is large compared to the ion energy at the plasma boundary, then the distance s_0 is just the Child-Langmuir distance corresponding to the ion current density J and the potential difference V_0 between the plasma and the grid.

41801 Photoelectron spectroscopy using a supersonic molecular beam source. The ^{2}B/sub 3u/$+e^- \leftarrow {}^1$A/sub g/ transition in ethylene. Dehmer, P.M.; Dehmer, J.L. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* 70: No. 10, 4574-4580(15 May 1979).

We show that a supersonic molecular beam source will significantly improve the quality of molecular photoelectron spectra by reducing both Doppler and rotational broadening of the target gas, and that the benefits of such a source are realized for spectrometers operating at resolutions of $<$ or $=$20 meV. The photoelectron spectra of the O_2^+ ^{2}Pi/sub g/,v'=0$+e^- \leftarrow O_2$ $^3\Sigma$/sub g/$^-$ transition in molecular oxygen and the $C_2H_4^+$ ^{2}B/sub 3u/ $+e^- \leftarrow C_2H_4$ ^{1}A/sub g/ transition in ethylene are presented as examples of the technique. Newly resolved vibrational structure in the ethylene spectrum is compared to recent theoretical calculations and to the vibrational structure of the 3s Rydberg transition at 1744 A.

41802 Projectile-charge-state dependence of target L-shell ionization by 1.86-MeV/amu fluorine and silicon ions and 1.8-MeV/amu chlorine ions. McDaniel, F.D.; Toten, A.; Peterson, R.S.; Duggan, J.L.; Wilson, S.R.; Gressett, J.D.; Miller, P.D.; Lapicki, G. (Depart-

ment of Physics, North Texas State University, Denton, Texas 76203). *Phys. Rev., A;* **19**: No. 4, 1517-1524(Apr 1979).

Lα x-ray-production cross sections have been measured for solid targets of $_{60}$Nd, $_{67}$Ho, and $_{79}$Au for 1.86-MeV/amu $^{19}_{9}$F and $^{28}_{14}$Si, and 1.8-MeV/amu $^{36}_{17}$Cl ions as a function of the incident charge state. From the projectile-charge-state dependence of the cross sections, both direct-ionization and electron-capture contributions were extracted for a comparison to Coulomb ionization theories. The data provide supporting evidence for the theory of electron capture with a reduced binding effect. With standard fluorescence and Coster-Kronig yields uncorrected for multiple-ionization effects, the direct ionization theories did not simultaneously reproduce the projectile-Z_1 and target-Z_2 dependences of the data.

41803 Angular distribution of atoms sputtered from the surface of an amorphous target. Pletnev, V.V. (Engineering-Physics Institute, Moscow). *Sov. Phys. - Solid State (Engl. Transl.);* **20**: No. 11, 1950-1952(Nov 1978).

A model of the sputtering of the surface of an amorphous target by fast ions is proposed. The model is used to derive simple expressions for the angular distributions (in absolute units) of the emitted atoms and their dependences on the angle of incidence and on the energy of the primary ions.

41804 Negative component in hydrogen and deuterium beams scattered by a copper target. Zhabrev, G.I.; Kurnaev, V.A. (Moscow Engineering Physics Institute). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **4**: No. 9, 429-430(Sep 1978).

The energy spectra of the negative component in a beam of hydrogen or deuterium ions reflected from a polycrystalline copper target are studied. The ratio of the magnitudes of negative and positive components of the reflected beam depends only on the energy with which the particles leave the target.(AIP)

41805 Transport of a high-current relativistic electron beam in a cusp field in the Angara—Kol'tso system. Babykin, M.V.; Bartov, A.V.; Kobs, Y.V.; Lin, D.N.; Mizhiritskii, V.I.; Pen'kina, V.S.; Rudakov, L.I.; Sukhov, A.D.; Tarumov, E.Z. *Sov. Tech. Phys. Lett. (Engl. Transl.);* **4**: No. 9, 441-443(Sep 1978).

Research is reported on the transport of a disk-shaped high current relativistic electron beam by means of a cusped geometry magnetic field and the trapping of relativistic electrons using opposed fields. It is concluded that the efficiency of beam transport is at least 85% for a total transport distance of 0.5 meter. (AIP)

41806 Ion-induced continuum x-ray emission. Saris, F.W.; Hoogkamer, T.P. (FOM-Institute for Atomic and Molecular Physics, Amsterdam, Netherlands). pp 509-536 of Atomic Physics 5. Marrus, R.; Prior, M.; Shugart, H. (eds.). New York, NY; Plenum Press (1977).

From 5. international conference on atomic physics; Berkeley, CA, USA (26 Jul 1976).

This paper reviews continuum x-ray emission produced by ion-impact on gaseous and solid targets. Molecular orbital x-rays are considered in detail in order to establish the circumstances under which they can be distinguished from radiative electron capture and from various kinds of bremsstrahlung. The level of understanding of continuum x-ray production appears to parallel that of ion-induced inner-shell ionization in general. 79 references.

ATOMIC AND MOLECULAR PROPERTIES

REFER ALSO TO CITATION(S) 41834, 41902

41807 (COO—2753-101) **Role of relativistic effects and configuration mixing on the 1s2s3p ^{4}P (J=5/2) state of argon.** Tunnell, T.W.; Can, C.; Bhalla, C.P. (Kansas State Univ., Manhattan (USA). Dept. of Physics). 1978. Contract EY-76-S-02-2753. 3p. (CONF-781113—39). Dep. NTIS, PC A02/MF A01.

From 5. conference on application of small accelerators; Denton, TX, USA (6 Nov 1978).

The first-order matrix elements vanish for the energetic K and L x-rays and Auger transitions for the 1s2s3p ^{4}P°/sub 5/2/ states due to the selection rules governing the spin quantum numbers. However, "spin-forbidden" transitions are possible when considering higher order multipoles. Cascading to the 1s2p^2 ^{4}P/sup e/ levels is possible in the configuration mixing with the 1s2p3s ^{4}P° and 1s2p3d ^{4}P° terms. The results of relativistic calculations and of the configuration mixing are presented for the case of 1s2s3p ^{4}P°/sub 5/2/ state in argon. 11 references.

41808 (COO—2753-102) **Theoretical lifetimes and fluorescence yields for multiply-ionized fluorine.** Tunnell, T.W.; Can, C.; Bhalla, C.P. (Kansas State Univ., Manhattan (USA). Dept. of Physics). 1978. Contract EY-76-S-02-2753. 6p. (CONF-781113—38). Dep. NTIS, PC A02/MF A01.

From 5. conference on application of small accelerators; Denton, TX, USA (6 Nov 1978).

Theoretical lifetimes and multiplet partial fluorescence yields for various fluorine ions with a single K-shell vacancy were calculated. For few-electron systems, the lifetimes and line fluorescence yields were computed in the intermediate coupling scheme with the inclusion of the effects arising from configuration interactions. 6 references.

41809 Electronic structure of HgCl and HgBr. Wadt, W.R. (Theoretical Division, University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Appl. Phys. Lett.;* **34**: No. 10, 658-660(15 May 1979).

Ab initio configuration interaction calculations using effective core potentials are presented for the low-lying electronic states of HgCl and HgBr. The B→X laser wavelengths and vibrational constants for the B and X states are in very good agreement with experiment. The equilibrium separations (R/sub e/) for the B and X states in HgCl (HgBr) are found to be 2.42 (2.61 A) and 2.93 A (3.04 A), respectively. The purely electronic radiative lifetime for the B state in HgCl (HgBr) is calculated to be 27.5 ns (27.6 ns). The mixing of ionic and covalent character in the X and B states and its effect on the R dependence of the transition moment is discussed briefly. Finally, the possibility of self-absorption is considered.

41810 Depolarized scattering of atomic fluids with variable polarizability. Alder, B.J.; Beers, J.C. II; Strauss, H.L.; Weis, J.J. (Lawrence Livermore Laboratory, Livermore, California 94550). *J. Chem. Phys.;* **70**: No. 9, 4091-4094(1 May 1979).

The calculated band shapes and intensities of the depolarized light scattering from dense systems of atoms interacting with either hard-sphere or Lennard—Jones potentials are shown to agree qualitatively with experiment, if an empirical form for the pairwise polarizability distortion anisotropy is used.

41811 Aspects of the percolation process for hydrogen-bond networks in water. Geiger, A.; Stillinger, F.H.; Rahman, A. (Institut fuer Physikalische Chemie und Elektrochemie der Universitaet Karlsruhe, West Germany). *J. Chem. Phys.;* **70**: No. 9, 4185-4193(1 May 1979).

Sets of configurations selected from three molecular dynamics simulations for liquid water have been analyzed for the distribution of hydrogen-bond clusters. Two simulations correspond to water at 1 g cm^{-3}, while the third corresponds to highly compressed water at 1.346 g cm^{-3}. An energy criterion was adopted for existence of a hydrogen-bond between two molecules. As the cutoff value for bonding increases (becomes more permissive), a bond percolation threshold is encountered at which initially disconnected clusters suddenly produce a large space-filling random network. At least for the model studied, any chemically reasonable definition of "hydrogen-bond" leads to this globally connected structure though a few disconnected fragments inhabit its interior. Although some polygonal closures can exist, the critical percolation threshold is apparently well predicted by Flory's theory of the gel point for dendritic polymerization.

41812 Accurate intermolecular potential for helium. Aziz, R.A.; Nain, V.P.S.; Carley, J.S.; Taylor, W.L.; McConville, G.T. (Department of Physics, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1). *J. Chem. Phys.;* **70**: No. 9, 4330-4342(1 May 1979).

A simple realistic and precise empirical intermolecular potential is proposed for helium. It possesses nearly the correct Hartree—Fock repulsion as well as the correct long range behavior. It was fitted to recent accurate intermediate temperature second virial coefficients and thermal conductivity data as well as high temperature viscosity values. It is able to predict second virial coefficients over an extended temperature range from 1.5 to 1475 K. Above 100 K it reproduces substantially all of the transport properties to within experimental error in a manner superior to all other potentials in existence. Below 100 K where the transport data are less reliable, it produces a good representation of the isotopic differences in the viscosity. It also predicts differential cross sections reasonably well. In spite of a few remaining discrepancies, when all the different macroscopic properties are considered, the potential produces the best representation of the helium interaction available at this time.

41813 Electronic and vibrational absorption spectrum of tantalum nitride (TaN) isolated in an argon matrix. Bates, J.K.; Gruen, D.M. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **70**: No. 9, 4428-4429(1 May 1979).

TaN was produced in a hollow cathode sputtering source and trapped in argon matrices at 14 °K. The absorption spectra was found to be most intense near 19 200 and 24 000 cm^{-1}.

41814 Emission and ionization induced by focused KrF-laser irradiation of UF_6. Wampler, F.B.; Rice, W.W.; Oldenborg, R.C.; Akerman, M.A.; Magnuson, D.W.; Smith, D.F.; Werner, G.K. (Los Alamos Scientific Laboratory, University of California, P. O. Box 1663, Los Alamos, New Mexico 87545). *Opt. Lett.;* **4**: No. 5, 143-145(May 1979).

Strong ultraviolet—visible emission and weak ionization are observed when room-temperature UF_6 is irradiated with a focused, 248-nm KrF laser. The emission consists of two temporally distinct decays, the longer-lived of which is quenched by Ar with a rate constant of 1.9 x 10^8 liter/mol-sec at 25°C.

41815 ν_2 band of N_2O as a frequency standard in the 17-μm region of the infrared. Reisfeld, M.J.; Flicker, H. (University of California, Los Alamos Scientific Laboratory, P. O. Box 1663, Los Alamos, New Mexico 87545). *Appl. Opt.;* **18**: No. 8, 1136-1138(15 Apr 1979).

Direct measurements of the absorption spectra of N_2O were made in order to determine if higher order terms are needed before the ν_2 band can serve as a frequency standard.(AIP)

41816 Configuration interaction effects on the odd parity levels of SI. McGuire, E.J. (Sandia Laboratories, Albuquerque, New Mexico 87185). *J. Opt. Soc. Am.;* **69**: No. 4, 525-532(Apr 1979).

The odd parity levels in SI contain two related major anomalies, a bound $(3s)^1(3p)^5\ ^3P$ term, with very small oscillator strengths to the $(3s)^2(3p)^4\ ^3P$ ground-state term. Configuration interaction calculations, with a discretized continuum model, by Cowan, Radziemski, and Kaufman predict a bound $(3s)^1(3p)^5\ ^3P$ term as a result of its strong interaction with the continuum. It is shown that the discretized continuum model is in error in its treatment of the continuum, and that an exact solution to an approximate model shows that the energy shift due to interaction with the continuum is weak. Hansen has treated the comparable strong perturber problem in the halogens as a two-level interaction problem between $(ns)^1(np)^6\ ^2S$ and $(ns)^2(np)^4\ ^1D$ $(nd)^2S$, using a term-dependent Hartree-Fock wave function for the latter level. Hansen's results are in reasonable agreement with the discretized continuum model. It is shown that this agreement is fortuitous, as the two approaches treat different continuum interactions. In addition it is shown that Hansen's two-level treatment is not generalizable. For SI both $(3s)^2(3p)^3\ ^2D$ $(3d)^3P$ and $(3s)^2(3p)^3\ ^2P$ $(4s)^3P$ must be included in the calculation even though $(3s)^2(3p)^3\ ^2P$ $(4s)^3P$ interacts weakly with $(3s)^1(3p)^5\ ^3P$. Discrete CI calculations indicate that one can find reasonable overall agreement with the observed SI odd parity energy levels with J = 1 if the initial energy of the $(3s)^1(3p)^5\ ^3P$ is treated as a free parameter. Calculated level widths are in reasonable agreement with experiment, indicating no need to rescale calculated nondiagonal matrix elements. The calculated $(3s)^1(3p)^5\ ^3P$—$(3s)^2(3p)^4\ ^3P$ oscillator strengths are large, in contradiction to experiment. This fact and the need to use an adjustable $(3s)^1(3p)^5\ ^3P$ initial energy suggests a source of strong CI, not included in the basis set used. It is hypothesized that the missing strong source is the $(3s)^1(3p)^4(4p)$ configuration.

41817 L_1-L/sub 2,3/M/sub 4,5/ Coster-Kronig transition thresholds in the region 37 < or = Z < or = 56. Doyle, B.L.; Shafroth, S.M. (Department of Physics and Astronomy, University of North Carolina, Chapel Hill, North Carolina 27501). *Phys. Rev., A;* **19**: No. 4, 1433-1438(Apr 1979).

The L_1-L_2M/sub 4,5/ and L_1-L/sub M//sub 4,5/ Coster-Kronig transition thresholds in the atomic-number region 37 < or = Z < or = 56 are determined by bombardment of these elements with 2.5-MeV H^+ ions, and detection of the resulting L x rays with a curved-crystal spectrometer. The intensities of both the Lα and $L\beta_1$ satellites along with the total intensities of the Lα, $L\beta_1$, and Lβ/sub 3,4/ x rays which are produced during these collisions, are dependent upon the energetic permissibility of these Coster-Kronig transitions. The discontinuous nature of the intensity ratios as functions of atomic number indicates that the L_1-L_2M/sub 4,5/ and L_1-L/sub M//sub 4,5/ transitions are energetically allowed for the elements with atomic numbers in the regions Z < or = 39 or 40 and Z < or = 49 or 50, respectively.

41818 Atomic hydrogen in a uniform magnetic field: Low-lying energy levels for fields below 10^9 G. Starace, A.F.; Webster, G.L. (Behlen Laboratory of Physics, The University of Nebraska, Lincoln, Nebraska 68588). *Phys. Rev., A;* **19**: No. 4, 1629-1640(Apr 1979).

The wave function for an electron in combined Coulomb and uniform magnetic fields is expanded in oblate-spheroidal angle functions. The resulting Schroedinger equation for the radial function is solved for the energy levels by means of two different adiabatic approximations, which yield rigorous lower and upper bounds on the lowest exact energy levels for each symmetry state of the system. Results are presented for the level and binding energies of hydrogenic 1s, 2s, and 2p levels for magnetic fields in the range 10^7 < or = B < or ≈ 10^{11} G and compared with results of other authors. These results indicate that the present adiabatic approximation methods employing spherical symmetry may be expected to give reliable results for energies of low-lying hydrogenic levels for magnetic fields in the range 0 < or = B < or ≈ 10^9 G.

41819 Search for parity nonconserving optical rotation in atomic bismuth. Baird, P.E.G.; Brimicombe, M.W.S.M.; Roberts, G.J.; Sandars, P.G.H.; Stacey, D.N. (Clarendon Lab., Oxford, England). pp 27-35 of Atomic Physics 5. Marrus, R.; Prior, M.; Shugart, H. (eds.). New York, NY; Plenum Press (1977).

From 5. international conference on atomic physics; Berkeley, CA, USA (26 Jul 1976).

Preliminary results are reported from an experiment on the 648 nm J = 3/2 J = 5/2 transition in bismuth. Optical rotation close to an allowed M_1 absorption line in such a heavy element would indicate weak neutral currents. The optical rotation, if it exists, is found to be much smaller than had been expected. (GHT)

41820 Atomic-beam experiments at the ISOLDE-facility at CERN. Ekstroem, C.; Lindgren, I. (CERN, Geneva, Switzerland). pp 201-213 of Atomic Physics 5. Marrus, R.; Prior, M.; Shugart, H. (eds.). New York, NY; Plenum Press (1977).

From 5. international conference on atomic physics; Berkeley, CA, USA (26 Jul 1976).

A sixpole-fourpole ABMR apparatus has been connected to the ISOLDE facility at CERN and used for one-line experiments on very neutron-deficient isotopes of rubidium, cesium, and gold. Altogether, 22 new nuclear spins have been determined for these elements. Hyperfine-structure measurements, yielding information about the nuclear dipole moments, are in progress for these isotopes. With the target systems tested so far, it can be expected that isotopes of about 25 elements can be produced with sufficient yields for ABMR experiments. The technique applied so far can be extended in various respects. Conventional ABMR is restricted to elements with J not equal to 0 in the electronic ground state. Techniques for exciting the atoms into metastable states are available, which may circumvent this restriction in many cases. The combination of atomic-beam magnetic deflection and laser excitation opens very interesting possibilities to investigate the isotope shifts for long sequences of isotopes. The same technique can also be used to measure the nuclear quadrupole coupling of excited atomic states, which is of particular importance in cases where such coupling is absent in the ground state.

41821 High resolution laser spectroscopy of radioactive sodium isotopes. Duong, H.T.; Jacquinot, P.; Juncar, P.; Liberman, S.; Pinard, J.; Vialle, J.L.; Huber, G.; Klapisch, R.; Thibault, C. (CNRS, Orsay, France). pp 215-225 of Atomic Physics 5. Marrus, R.; Prior, M.; Shugart, H. (eds.). New York, NY; Plenum Press (1977).

From 5. international conference on atomic physics; Berkeley, CA, USA (26 Jul 1976).

In these experiments, sodium isotopes produced by spallation of aluminium with 150 MeV protons from the Orsay synchrocyclotron were studied by laser excitation and magnetic detection of optical resonances. Hyperfine structure of the D_1 and D_2 lines are shown. (GHT)

41822 Nuclear excitation by electron transition. Morita, M. (Osaka Univ., Japan). pp 227-237 of Atomic Physics 5. Marrus, R.; Prior, M.; Shugart, H. (eds.). New York, NY; Plenum Press (1977).

From 5. international conference on atomic physics; Berkeley, CA, USA (26 Jul 1976).

When an electron hole moves from an inner orbit to an adjacent one, the energy corresponding to the difference of the binding energies for these two orbits is usually carried away by the emitted characteristic x ray or the Auger electron. In addition to these two processes, there is another possible mode of this energy release by exciting the atomic nucleus. This is called the nuclear excitation by electron transition, in short NEET. The probability of NEET is generally small compared with that of the x-ray or Auger-electron emission. It is, however, measurable in some cases. The reason why NEET has been studied theoretically is described. Preliminary data in ^{189}Os experiments are introduced. The implications of NEET are also discussed.

41823 Hyperfine and isotope shift measurements far off stability by optical pumping. Otten, E.W. (Univ. Mainz, Ger.). pp 239-268 of Atomic Physics 5. Marrus, R.; Prior, M.; Shugart, H. (eds.). New York, NY; Plenum Press (1977).

From 5. international conference on atomic physics; Berkeley, CA, USA (26 Jul 1976).

Optical pumping experiments performed at the ISOLDE facility of the CERN synchrocyclotron are reviewed. These cover mercury isotopes from mass number 181 to 205. The impact of these measurements on nuclear structure research far off stability is discussed. (GHT)

41824 Highly-excited atoms. Kleppner, D. (Massachusetts Inst. of Tech., Cambridge, MA). pp 269-281 of Atomic Physics 5. Marrus, R.; Prior, M.; Shugart, H. (eds.). New York, NY; Plenum Press (1977).

From 5. international conference on atomic physics; Berkeley, CA, USA (26 Jul 1976).

Recent experimental advances in the study of highly-excited atoms and molecules are reviewed. Rydberg states of krypton, rate

constants for electron attachment to SF_6, cross sections for angular momentum changing collisions of nd states of sodium in various rare gases, Stark effect level diagrams for sodium, and ionization curves for cesium, hydrogen, and sodium are shown. 27 references. (GHT)

41825 Spectroscopy of highly ionized atoms produced by a low-inductance vacuum spark. Feldman, U.; Doschek, G.A. (Naval Research Lab., Washington, DC). pp 473-491 of Atomic Physics 5. Marrus, R.; Prior, M.; Shugart, H. (eds.). New York, NY; Plenum Press (1977).

From 5. international conference on atomic physics; Berkeley, CA, USA (26 Jul 1976).

The low-inductance vacuum spark as a high temperature light source for spectroscopy of highly ionized atoms is described. Emission line spectroscopy of HI and HeI isoelectronic sequences is reviewed, including emission line profiles in LIVS spectra, and absorption lines are covered. (GHT)

POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES

41826 Hadronic atoms. Wu, C.S. (Columbia Univ., New York, NY). pp 63-94 of Atomic Physics 5. Marrus, R.; Prior, M.; Shugart, H. (eds.). New York, NY; Plenum Press (1977).

From 5. international conference on atomic physics; Berkeley, CA, USA (26 Jul 1976).

At present, 5 different types of exotic atoms have been observed by capture of the slowed negative muons, pions, kaons, sigma hyperons and anti-protons into atomic orbits. The muon in a muonic atom is able to reach the lowest orbit (the 1S orbit) and spend a considerable fraction of its life inside the nucleus. Hadrons, on the other hand, interact strongly with the nucleus and are generally captured by the nucleus before ever reaching the lower orbits. The properties of the hadronic atoms are reviewed. (GHT)

41827 Detection of π-μ Coulomb bound states. Coombes, R. (Stanford Univ., CA); Flexer, R.; Budick, B. pp 95-101 of Atomic Physics 5. Marrus, R.; Prior, M.; Shugart, H. (eds.). New York, NY; Plenum Press (1977).

From 5. international conference on atomic physics; Berkeley, CA, USA (26 Jul 1976).

Atoms consisting of a pion and a muon produced in the decay K/sub L/$^0 \rightarrow$ ($\pi\mu$)/sub Atom/ν have been observed. This represents the first observations of an atom composed of two unstable particles and of an atomic decay of an elementary particle.

41828 Review of precision positronium experiments. Mills, A.P. Jr. (Bell Labs., Murray Hill, NJ); Berko, S.; Canter, K.F. pp 103-124 of Atomic Physics 5. Marrus, R.; Prior, M.; Shugart, H. (eds.). New York, NY; Plenum Press (1977).

From 5. international conference on atomic physics; Berkeley, CA, USA (26 Jul 1976).

Great strides have been made in the study of the properties of positronium in the quarter century since its discovery. The ground state hyperfine interval is now known to a precision of 5 ppM, the triplet decay rate is being measured with accuracies approaching one part in 10^3, the Lyman α radiation from the first excited state of positronium has been observed, and a fine structure interval in this $n=2$ level has been measured with a precision of three parts in 10^4, confirming the Lamb shift-like radiative corrections to a few percent. It is to be hoped that further work making use of recent advances in positronium production will allow new aspects of the exotic positronium atom to be investigated and new precision measurements of its known properties to be made.

COLLISION PHENOMENA

41829 (LBL—8589) Collisions of halogen (^{2}P) and rare gas (^{1}S) atoms. Becker, C.H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1978. Contract W-7405-ENG-48. 115p. Dep. NTIS, PC A06/MF A01.

Thesis.

Differential cross sections I (Θ) at several collision energies measured in crossed molecular beam experiments are reported for several combinations of halogen atoms (^{2}P) scattered off rare gas-rare gas atoms ($^1S_0$), namely, F + Ne, F + Ar, F + Kr, F + Xe, Cl + Xe. The scattering is described by an elastic model appropriate to Hund's case c coupling. With the use of this model, the X 1/2, I 3/2, and II 1/2 interaction potential energy curves are derived by fitting calculated differential cross sections, based on analytic representations of the potentials, to the data. The F - Xe X 1/2 potential shows a significant bonding qualitatively different than for the other F-rare gases. The I 3/2 and II 1/2 potentials closely resemble the van der Waals interactions of the one electron richer ground state rare gas-rare gas systems. Coupled-channel scattering calculations are carried out for F + Ar, F + Xe, and Cl + Xe using the realistic potential curves derived earlier. The results justify the use of the elastic model, and give additional information on intramultiplet and intermultiplet transitions. The transitions are found to be governed by the crossing of the two $\Omega = 1/2$ potentials in the complex plane. The measured I (θ) and I (Θ) derived from the coupled-channel computations show small oscillations or perturbations (Stueckelberg oscillations) though quantitative agreement is not obtained.The nature of the anomalous F - Xe X 1/2 potential is discussed as is the approximation of a constant spin orbit coupling over the experimentally accessible range of internuclear distances for these open shell molecules. 55 references.

41830 (LBL—9057) Crossed molecular beam studies of unimolecular reaction dynamics. Buss, R.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1979. Contract W-7405-ENG-48. 165p. Dep. NTIS, PC A08/MF A01.

Thesis.

The study of seven radical-molecule reactions using the crossed molecular beam technique with supersonic nozzle beams is reported. Product angular and velocity distributions were obtained and compared with statistical calculations in order to identify dynamical features of the reactions. In the reaction of chlorine and fluorine atoms with vinyl bromide, the product energy distributions are found to deviate from predictions of the statistical model. A similar effect is observed in the reaction of chlorine atoms with 1, 2 and 3-bromopropene. The reaction of oxygen atoms with ICl and CF_3I has been used to obtain an improved value of the IO bond energy, 55.0 +- 2.0 kcal mol^{-1}. In all reactions studied, the product energy and angular distributions are found to be coupled, and this is attributed to a kinematic effect of the conservation of angular momentum.

41831 (UCRL—13993) Rayleigh scattering amplitudes for neon and carbon: 100 eV to 30 keV. Parker, J.C.; Pratt, R.H. (Pittsburgh Univ., PA (USA). Dept. of Physics). 1 May 1979. Contract W-7405-ENG-48. 39p. Dep. NTIS, PC A03/MF A01.

A tabulation is presented for the amplitudes and differential cross sections for Rayleigh scattering from neon and carbon in the energy range from 100 eV to 30 keV, at 5° intervals. At these energies Rayleigh scattering gives the only significant contribution to the total elastic scattering differential cross section for photon-atom scattering. The amplitudes and cross sections can now be calculated to better than 1% for all energies between 0.1 keV and 10 MeV. 7 references. (JFP)

41832 (UCRL—13994) Calculating Rayleigh scattering amplitudes from 100 eV to 10 MeV. Parker, J.C.; Reynaud, G.W.; Botto, D.J.; Pratt, R.H. (Pittsburgh Univ., PA (USA). Dept. of Physics). 1 May 1979. Contract W-7405-ENG-48. 107p. Dep. NTIS, PC A06/MF A01.

Portions of document are illegible.

An attempt is made to explain how to calculate the contribution to elastic photon-atom scattering due to Rayleigh scattering (the scattering off bound electrons) in the photon energy range 100 eV $\leq$ W $\leq$ 10 MeV. All intermediate calculations are described, including the calculation of the potential, bound state wave functions, matrix elements, and final cross sections. 12 references. (JFP)

41833 Electron and ion scattering by excited hydrogen atoms. Baryshnikov, F.F.; Lisitsa, V.S. (I. V. Kurchatov Institute of Atomic Energy, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **4**: No. 5, 660-661(Sep 1978).

Quantum cross sections and scattering amplitudes are calculated using wave functions derived from the dipole approximation. (AIP)

41834 Atomic Physics 5. Marrus, R.; Prior, M.; Shugart, H. (eds.). New York, NY; Plenum Press (1977). 573p. (CONF-760730—).

From 5. international conference on atomic physics; Berkeley, CA, USA (26 Jul 1976).

Reviews of the current state of research in atomic physics are presented. Experimental work on such topics as search for parity violation, spectroscopy and collision processes of fast, highly-stripped heavy ions, exotic atoms, high Rydberg states, laser spectroscopy, photoelectron spectroscopy, and others is described. Twenty-seven papers were prepared for the data base. (GHT)

41835 Multiphotonic high resolution spectroscopy. Cagnac, B. (Ecole Normale Superieure, Paris, France). pp 147-166 of Atomic Physics 5. Marrus, R.; Prior, M.; Shugart, H. (eds.). New York, NY; Plenum Press (1977).

From 5. international conference on atomic physics; Berkeley, CA, USA (26 Jul 1976).

Work done during the previous 3 years with Doppler-free multiphotonic spectroscopy is reviewed. Experimental problems are discussed, and the application of the Doppler-free two-photon method is reviewed. 46 references. (GHT)

41836 Time resolved laser spectroscopy: quantum beats and superradiance. Haroche, S.; Fabre, C.; Gross, M.; Pillet, P. (Ecole

Normale Superieure, Paris, France). pp 179-200 of Atomic Physics 5. Marrus, R.; Prior, M.; Shugart, H. (eds.). New York, NY; Plenum Press (1977).

From 5. international conference on atomic physics; Berkeley, CA, USA (26 Jul 1976).

Recent time resolved transient experiments in laser spectroscopy are described. Incoherent pumping time resolved fluorescence experiments are reviewed. It is shown that quantum beat experiments are well suited for observation of superradiance or collective spontaneous emission effects. In the second part, it is shown that this effect may be investigated in some very simple experimental situations in alkali atoms and may even lead to interesting applications. (GHT)

41837 Anisotropy and time dependence in atomic collisions. Macek, J. (Univ. of Nebraska, Lincoln). pp 283-291 of Atomic Physics 5. Marrus, R.; Prior, M.; Shugart, H. (eds.). New York, NY; Plenum Press (1977).

From 5. international conference on atomic physics; Berkeley, CA, USA (26 Jul 1976).

The connection between anisotropy and time dependence is reviewed, and results from recent measurements and theories of the anisotropy of collision excited states are discussed. (GHT)

41838 R-matrix theory of atomic and molecular processes. Burke, P.G. (Queen's Univ., Belfast, Ireland). pp 293-311 of Atomic Physics 5. Marrus, R.; Prior, M.; Shugart, H. (eds.). New York, NY; Plenum Press (1977).

From 5. international conference on atomic physics; Berkeley, CA, USA (26 Jul 1976).

In the development of new methods for electron-atom and electron-molecule scattering, the R-matrix method seems particularly promising. Recent developments are described which have been made in this theory, and applications are considered in electron scattering and a broad range of other atomic and molecular processes including polarizabilities, long range atomic force constants, binding energies, and photoionization cross sections. (GHT)

41839 Influence of electron capture on x-ray production in heavy-ion collisions. Betz, H.D.; Bell, F.; Spindler, E. (Univ. Muenchen, Garching, Ger.). pp 493-508 of Atomic Physics 5. Marrus, R.; Prior, M.; Shugart, H. (eds.). New York, NY; Plenum Press (1977).

From 5. international conference on atomic physics; Berkeley, CA, USA (26 Jul 1976).

Recent investigations are summarized which show that electron capture and other quenching processes can play an important role for the x-ray production in ion-atom collisions. In particular, electron capture affects the distribution of excited projectile states inside solids and causes nonproportional target-thickness dependence of projectile x-ray yields. This may give rise to difficulties in the measurement of projectile x-ray cross sections, but allows determination of lifetimes of projectile states. New results are presented on the oscillatory behavior of projectile x-ray yields as a function of target species and on the spectral shape of radiative electron capture.

ATOMIC AND MOLECULAR THEORY

REFER ALSO TO CITATION(S) 41834

41840 Motional Stark effect on Li vapor photosbsorption in high magnetic fields. Crosswhite, H.; Fano, U.; Lu, K.T.; Rau, A.R.P. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev. Lett.;* **42**: No. 15, 963-966(9 Apr 1979).

Calculation of the motional Stark effect for B ~ 50 kG shows it to become dominant along Rydberg series of light elements at T ~ 1000°C before the diamagnetic shift changes the spectrum from Rydberg to Landau type, thus accounting for the 1/2hω/sub c/ spacing observed in Li. This spacing is preserved when both of the competing effects: motional Stark and Landau modulation: are strong. The spectrum appears to depend critically on the relative position of the thresholds for the onset ot the two effects.

41841 General form of the quantum-defect theory. Greene, C.; Fano, U.; Strinati, G. (Department of Physics, University of Chicago, Chicago, Illinois 60637). *Phys. Rev., A;* **19**: No. 4, 1485-1509(Apr 1979).

The quantum-defect-theory (QDT) treatment of an electron in the Coulomb field surrounding an ionic core is recast in a form largely independent of field characteristics and thus applicable, e.g., to square wells or to the Morse fields of diatomic molecules. The reformulation parallels Seaton's classification of alternative Coulomb-field wave functions, and makes it applicable to other fields. Wronskians of alternative pairs of base functions have an important role in the theory. For electron energies $\epsilon < 0$ in a Coulomb field these Wronskians reduce to trigonometric functions of $\nu = (-2\epsilon)$/sup -1/2/, familiar in the QDT; other fields lead to trigonometric functions of different arguments. Quantum defects are generalized to eigenvalues of a reaction matrix, as in Seaton's work, but this matrix can now be calculated even below threshold energies with the introduction of a "smooth" Green's function appropriate to QDT applications.

41842 Two-level model for near saturated fluorescence in diatomic molecules. Lucht, R.P.; Laurendeau, N.M. (Purdue University, Combustion Laboratory, School of Mechanical Engineering, West Lafayette, Indiana 47907). *Appl. Opt.;* **18**: No. 6, 856-862(15 Mar 1979).

The near saturated behavior of diatomic molecules is modeled by considering the interactions of two sets of rotational levels. The molecules are assumed to be subjected to high intensity laser radiation tuned to one particular rotational transition between the sets of levels. Previous two-level models for atomic fluorescence are modified to account for the strong coupling of rotational energy levels in molecules. The steady-state rate equations for the system are manipulated to give simple expression for the total fluoresence power in terms of the electronic quenching rate Q_{21}, the spontaneous emission rate A_{21}, the stimulated emission rate $B_{21}I_{21}$, and the population fractions of the lower and upper levels which are directly excited by the laser, $F_1(e)$ and $F_2(e)$, respectively. When the ratio of the rotational relaxation rates Q_{22} and Q_{11} to Q_{21} is on the order of 100 or less, the distribution of molecules among rotational levels is found to be markedly non-Boltzmann. The influence of the non-Boltzmann distribution on data interpretation is discussed.

41843 (UCRL-Trans—11472) Shell effects in the equation of state of a cold, highly compressed substance. Shpatakovskaya, G.V. (AN SSSR, Moscow. Inst. Prikladnoj Matematiki). Mar 1979. Translation of Preprint No. 54, 1975. 35p. Dep. NTIS, PC A03/MF A01.

The generalized Thomas—Fermi model suggested earlier, allowing the description of shell effects in an atom, is applied to calculation of the energy and equation of state of a compressed solid at zero temperature and a pressure of P much > e/sup z//a_0/sup y/ ≃ 300 mbar. The shell effects at these levels of compression result in phase transitions of the first kind. The characteristics of these phase transitions are calculated for various elements. It is shown that the corresponding jumps in density are quite great, which may be significant for astrophysical applications. The variation in atomic volume of an element with its atomic number at a fixed pressure is also calculated.

41844 Parity violation effects induced by neutral currents in atoms. Bouchiat, C.; Bouchiat, M.A.; Pottier, L. (Laboratoire de Physique de l'Ecole Normale Superieure, Paris, France). pp 1-21 of Atomic Physics 5. Marrus, R.; Prior, M.; Shugart, H. (eds.). New York, NY; Plenum Press (1977).

From 5. international conference on atomic physics; Berkeley, CA, USA (26 Jul 1976).

It is shown that the fields of Weak Interactions and Atomic Physics are becoming very close together. In spite of several experimental difficulties, it is now reasonable to expect significative information about fundamental properties of weak neutral current interaction between atomic electrons and nuclei to emerge, in a near future, from the search for P without T violation atomic physics experiments.

41845 Relativistic magnetic-dipole transitions in atoms, ions, and psions. Sucher, J. (Univ. of Maryland, College Park). pp 415-451 of Atomic Physics 5. Marrus, R.; Prior, M.; Shugart, H. (eds.). New York, NY; Plenum Press (1977).

From 5. international conference on atomic physics; Berkeley, CA, USA (26 Jul 1976).

A survey of events leading up to the present interest in relativistic M1 transitions in atomic physics is presented. The results of atomic beam-foil experiments from 1970 through 1975 are described, the theory of M1 transitions for He-like ions is presented, and the present comparison of theory and experiment is reviewed. The charmonium model is reviewed, and the theory of M1 transitions is extended to this case, and the current status of the psion radiative decays is described. 60 references. (GHT)

41846 Ionization of inner shells of atoms taking account of outer shell rearrangement. Amusia, M.Ya. (Ioffe Physical-Technical Inst., Leningrad, USSR). pp 537-565 of Atomic Physics 5. Marrus, R.; Prior, M.; Shugart, H. (eds.). New York, NY; Plenum Press (1977).

From 5. international conference on atomic physics; Berkeley, CA, USA (26 Jul 1976).

The application of the general many-body theory and methods formulated with its help, in particular, the so-called random phase approximation with exchange (RPAE) and the many-body perturbation theory (MBPT) makes possible a description of ionization processes for many outer and intermediate shells of a number of atoms. This investigation of outer- and intermediate-shell ionization by photons and electrons demonstrates the collective character of these processes and the possibility of describing them by RPAE. 28 references. (GHT)

GENERAL FLUID DYNAMICS

41847 Kelvin—Helmholtz-like instability of a shear layer subject to free boundary conditions. Mjolsness, R.C. (Theoretical Division, University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Fluids;* **22**: No. 6, 1213-1215(Jun 1979).

For free boundary conditions a shear layer with linear velocity profile supports irrotational disturbances, one mode being unstable when its wavelength $\lambda > 2.619$ times the thickness h of the shear layer. For long wavelengths the dispersion relation of the mode approaches the Kelvin—Helmholtz form.

41848 Perturbation method for classical atomic fluids which have a repulsive pair potential. Johnson, E. (Chemistry Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Chem. Phys.;* **70**: No. 10, 4597-4602(15 May 1979).

A new method for choosing a reference pair potential for atomic fluids is presented. This method and the optimized cluster theory are used to calculate pair distribution functions for a number of classical fluids. The results indicate that pair distribution functions obtained by this method are very accurate for fluids which have a repulsive pair potential.

41849 Kinetic theory of reacting fluid mixtures. I. The BBGKY hierarchy in arrangement channel quantum mechanics. Hoffman, D.K.; Kouri, D.J.; Top, Z.H. (Ames Laboratory, USDOE and Department of Chemistry, Iowa State University, Ames, Iowa 50011). *J. Chem. Phys.;* **70**: No. 10, 4640-4655(15 May 1979).

The statistical mechanics of reacting fluid mixtures is considered using arrangement channel quantum mechanics. In this theory, the many body wave function, psi, is expressed in terms of arrangement channel components psi/sub b/ which satisfy coupled time dependent equations. Using the properties of the psi/sub b/, we obtain the corresponding generalization of the density matrix rho denoted rho/sub alphabeta/ and the quantum "Liouville equation" which it satisfies. Reduced arrangement channel density matrices are introduced and are found to satisfy a generalization of the BBGKY hierarchy for reactive mixtures. The properties of the hierarchy are explored, and it is shown that the streaming terms in succeeding members of the hierarchy have increasing connectivity appropriate to the number of atoms in the contributing arrangement channels. The resulting hierarchy can serve as the rigorous starting point for developing statistical theories of reactive fluids. For example, it can be used to derive a Boltzmann equation appropriate to reacting gaseous mixtures.

41850 Molecular dynamics simulation of dense gases. I Test particle motion. Chen, S.H.; Rahman, A. (Argonne National Lab., IL). *Mol. Phys.;* **34**: No. 5, 1247-1262(1977).

A system of 500 Lennard-Jones particles was simulated by computer molecular dynamics. Calculations were made at three densities and three temperatures ranging from below the critical density at high temperature to the triple-point density and temperature. Besides the equilibrium pair-correlation function the dynamical quantities calculated were the time dependence of the moments (X^2) and (X^4) of the displacement, velocity autocorrelation function and test particle correlation functions: F/sub s/(k,t) and S/sub s/(k,ω). Both the full potential and a truncated one (i.e. without the attractive part) were used in the calculation to investigate the effects of the attractive part on the above quantities. The results are then compared with the recently developed generalized hard-sphere Enskog theory of dense gases. At low density and without the attractive part the results are in good agreement with theory; however, this is not so in the presence of the attractive part which modifies the detailed dynamical behaviour of the test particle to a considerable extent. At high densities the attractive part is much less important but, as expected, the results do not agree with theory. 37 references.

ELECTROHYDRODYNAMICS

41851 Study of an electrically driven jet. Horning, D.W.; Hendricks, C.D. (University of West Haven, New Haven, Connecticut 06516). *J. Appl. Phys.;* **50**: No. 4, 2614-2617(Apr 1979).

This is a study of the charge distribution and the forces on an electrically driven jet. A numerical solution of the charge distribution is presented, based on the measurement of the jet profile and the jet current. The influence of the charge distribution and fluid conductivity on jet length is considered. As a check on the charge distribution calculations, the electric driving forces are compared to the reaction forces.

SUPERFLUIDITY

41852 (LA—7754-PR) Low temperature physics and engineering. Quarterly progress report, October 1—December 31, 1978. Keller, W.E. (comp.). (Los Alamos Scientific Lab., NM (USA)). Apr 1979. Contract W-7405-ENG-36. 50p. Dep. NTIS, PC A03/MF A01.

This report summarizes the significant progress achieved in several programs carried out in the Los Alamos Scientific Laboratory's Low Temperature Physics and Cryogenic Engineering Group (Q-10) during the period October 1 to December 31, 1978. Progress is documented for the following areas: assessment of problem areas in hydrogen energy delivery systems; superfluid helium hydrodynamics; equation of state of helium at high pressure; helium—tritium complex formation; magnetic studies of solids at low temperature; muon spin rotation studies; experiments dealing with the destruction of superconductivity by current; nondestructive electric field probe; electrical and cryogenic engineering tests for the development of a dc superconducting power transmission line; development of conductors, electrical control apparatus, large Dewar vessels, and magnetic coils for superconducting magnetic energy storage devices, as well as desigrs of these units for power sytem stabilization; design, testing, and procurement of equipment for separating and handling large amounts of tritium—deuterium mixtures for systems to be used in conjunction with tokamak fusion reactors; and experiments leading to designs for magnetic refrigerators to be used for superconducting device applications in the electric power industry.

41853 Self-focusing of second sound in superfluid helium. Nemirovskii, S.K. (Institute of Thermal Physics, Siberian Branch, Academy of Sciences of the USSR). *Sov. J. Low Temp. Phys. (Engl. Transl.);* **4**: No. 10, 577-580(Oct 1978).

The Hamiltonian formalism is used to study the behavior of wide wave packets of second sound near the temperature at which the nonlinear correction to the sound velocity vanishes. The interaction between first and second sounds is shown to result in self-focusing and self-channeling of wave packets. The critical intensities for observing this effect and the lateral dimension of the waveguide channel are calculated.

41854 Surface electrons in helium over macroscopic periodic structures. Ginzburg, V.L.; Monarkha, Y.P. (Physicotechnical Institute of Low Temperatures, Academy of Sciences of the Ukrainian SSR). *Sov. J. Low Temp. Phys. (Engl. Transl.);* **4**: No. 10, 580-582(Oct 1978).

It is shown that there is a new possibility of realizing a band-type spectrum for electrons in superlattices with a macroscopic period by using surface electrons in liquid helium. A substrate with a periodic surface profile (of the diffraction grating type) is proposed as the superlattice. The parameters of the electron spectrum are calculated and an analysis is made of the possibility of observing effects which are nonlinear (in the electric field).

41855 Influence of shortwave surface excitations of liquid helium on damping effects in a two-dimensional electron gas. Monarkha, Y.P. (Physicotechnical Institute of Low Temperatures, Academy of Sciences of the Ukrainian SSR). *Sov. J. Low Temp. Phys. (Engl. Transl.);* **4**: No. 9, 515-520(Sep 1978).

It is shown that two-ripplon radiation processes of shortwave excitation can turn out to be the fundamental energy relaxation mechanism of surface electrons in helium under different nonequilibrium conditions. The contribution of these processes to the excited Landau level width and the momentum and energy collision frequency of a two-dimensional electron gas is calculated. It is also shown that in the presence of a roton section in the spectrum of the surface excitations, the width of excited Landau levels is a nonmonotonic function of the magnetic field intensity H and has a singularity at certain values of H. The possibility of using the results obtained to investigate the surface excitation spectrum of liquid helium is studied.

41856 Thickness of films of He^3—He^4 liquid solutions. Ivantsov, V.G.; Shcherbachenko, R.I. (Physicotechnical Institute of Low Temperatures, Academy of Sciences of the Ukrainian SSR). *Sov. J. Low Temp. Phys. (Engl. Transl.);* **4**: No. 9, 570-571(Sep 1978).

The thickness of films of He^3—He^4 liquid solutions is calculated on the basis of permittivity data for these solutions by using the conclusions of the theory of Dzyaloshinskii, Lifshitz, and Pitaevskii. It is shown that the values of the thickness of films of He^3—He^4 solutions and pure He^4 practically coincide under identical conditions. Consideration is given to the effect of possible mechanisms which may lead to a difference in the He^3 concentration in the film and in the bulk liquid.

41857 Possibility of detecting condensate flows in an excitonic dielectric. Shevchenko, S.I. (Physicotechnical Institute of Low Temperatures, Academy of Sciences of the Ukrainian SSR). *Sov. J. Low Temp. Phys. (Engl. Transl.);* **4**: No. 9, 572-573(Sep 1978).

It is shown that condensate flows in an excitonic dielectric transfer charge and mass in the presence of a magnetic field. However, this transfer only occurs in the surface layer.

41858 Instability of the electron Fermi liquid in a magnetic field. Kaner, E.A.; Chebotarev, L.V.; Uvimana, E. (A. M. Gor'kii Khar'kov State University). *Sov. J. Low Temp. Phys. (Engl. Transl.);* 4: No. 9, 574-575(Sep 1978).

The possibility of instability and phase transition in a metal is investigated in a model with the lattice replaced by a homogeneous charge-compensating background. It is shown that the state of such a system can become unstable near a singularity of the density of states on the Fermi surface under the condition that the average value of the Landau function, computed on the extremal cross section of the Fermi surface, is negative. Unlike the usual situation, with decreasing temperature the system goes from the liquid to the gaseous phase.

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

41859 (ORO—2504-T1) **High energy accelerator and colliding beam user group. Progress report 1978/1979.** Snow, G. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). Dec 1979. Contract EY-76-C-05-2504. 56p. Dep. NTIS, PC A04/MF A01.

The High Energy Physics Group at the U. of Maryland engaged in a substantial number of different types of particle physics experiments. The largest and most important experiment is that on e^+e^- interactions. Three experiments were carried out to search for exotic particles or interactions: a heavy neutral lepton, muonium to antimuonium transitions, axions produced by an intense electron beam. No evidence for any of these phenomena was obtained, and the corresponding limitations on relevant parameters were deduced. 10 figures. (RWR)

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 41827, 41868, 41976

41860 Measurement of nucleon structure function in muon scattering at high q^2. Ball, R.C.; Bauer, D.; Chang, C.; Chen, K.W.; Hansen, S.; Kiley, J.; Kostoulas, I.; Kotlewski, A.; Litt, L.; Schewe, P.F.; Van Ginneken, A. (Michigan State University, East Lansing, Michigan 48824). *Phys. Rev. Lett.;* 42: No. 14, 866-869(2 Apr 1979).

The nucleon structure function, F_2, has been measured up to $q^2 = 120$ (GeV/c)^2 and for $40 < W^2 < 300$ GeV^2. The data exhibit a significant pattern of scaling violation. Compared to lower-energy data, F_2 shows an observable increase of $\sim 15\%$ at high q^2 for $x < 0.4$. The pattern of the increase may accommodate a threshold in W or new theoretical parametrizations.

41861 Angular dependences of the polarization of secondary protons from the $\gamma p \to \pi^0 p$ reaction at photon energies of 650 and 700 MeV. Zybalov, A.A.; Derebchinskii, A.I.; Konovalov, O.G.; Bratashevskii, A.S.; Nazyrov, V.R.; Tenishev, A.E.; Tonapetyan, S.G. (Khar'kov Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR). *Sov. J. Nucl. Phys. (Engl. Transl.);* 28: No. 1, 52-53(Jul 1978).

The polarizations of protons from the $\gamma p \to \pi^0 p$ reaction are measured for photon energies of 650 and 700 MeV and c.m. pion emission angles from 80 to 140°. The results are compared with the predictions of various theoretical analyses.

41862 Polarization of protons in the reactions $\gamma p \to \pi^0 p$ at angle θ/sub π/ = 100° c.m.s. in the second πN resonance. Derebchinskii, A.I.; Zybalov, A.A.; Konovalov, O.G.; Nazyrov, V.R.; Tenishev, A.E.; Tonapetyan, S.G. (Khar'kov Physico-technical Institute, Ukrainian Academy of Sciences). *Sov. J. Nucl. Phys. (Engl. Transl.);* 28: No. 1, 132(Jul 1978).

The energy dependence of the proton polarization was measured in th range 480—800 MeV using a telescope of optical spark chambers.(AIP)

WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 41827, 41860, 41867

41863 (AED-Conf—77-656-000, pp 205-216) **Study of ν interactions at Brookhaven using counter techniques.** Williams, H.H. (Pennsylvania Univ., Philadelphia (USA)). 1977.

From Symposium on lepton and photon interactions at high energies; Hamburg, F.R. Germany (25 Aug 1977).

A review is presented of neutrino elastic scattering, $\nu p \to \nu p$ and anti $\nu p \to$ anti νp, as observed by the Harvard-Pennsylvania-Wisconsin (HPW) and Columbia-Illinois-Rockefeller (CIR) experiments at Brookhaven National Laboratory. Results from the CIR experiment on (anti) $\nu N \to$ (anti) $\nu N\pi$sup(o) are also discussed.

41864 (BNL—26038) **Beam dump experiments at the AGS.** Soukas, A.; Bregman, M.; Galik, R. (Brookhaven National Lab., Upton, NY (USA); Harvard Univ., Cambridge, MA (USA); Pennsylvania Univ., Philadelphia (USA)). 1978. Contract EY-76-C-02-0016. 22p. Dep. NTIS, PC A02/MF A01.

Searches for the prompt production of weak or semi-strongly interacting particles in a neutrino beam dump and their subsequent interaction or decay were performed at the AGS. The experiment is detailed using the totally active liquid scintillator detector, and mention the results of the spark chamber detector. An exposure of a copper beam dump to two orders of magnitude more protons than in previous searches at 28 GeV has yielded 104 neutrino-like events in the detector. The events from the beam dump are compared directly with those from π and K decay neutrinos produced concurrently in the normal long neutrino decay path following a 15 cm brass target. The characteristics of the events are similar. However, when compared to the rate of events predicted by scaling the 15 cm target yields, the beam dump data show an excess of 45 +- 16 events. The excess events from the beam dump appear to deposit energies $\geq$ 1 GeV. Their source remains puzzling. Future experiments at the AGS could verify the existence of the effect, decrease the uncertainty in the predicted number of events from 30 to 10% by directly measuring the pion absorption length with a variable density target, search for threshold effects, and measure the sign of the charge of the existing muons. 22 references.

41865 (BNL—26039) **Neutrino oscillation searches at the AGS.** Soukas, A.; Bregman, M.; Galik, R. (Brookhaven National Lab., Upton, NY (USA); Harvard Univ., Cambridge, MA (USA); Pennsylvania Univ., Philadelphia (USA)). 1978. Contract EY-76-C-02-0016. 28p. Dep. NTIS, PC A03/MF A01.

A feasibility study of the time evolution of a long-lived ν/sub μ/ beam was performed. The proton momentum (1.5 GeV/c) was chosen to concentrate the ν/sub μ/ flux at very low energy where all background reactions are kinematically suppressed. Sensitivity to oscillations at large proper times tau Varies as l/p (where l is the flight length and p is the momentum of the neutrino) is greatly enhanced by the resulting low neutrino momentum. Possible transformations ν/sub μ/ $\to$ ν/sub e/ (searched for via ν/sub e/n $\to e^-$p reactions) were not observed in an exposure of 2 x 10^{18} protons on target. Ten possible ν/sub μ/n $\to \mu^-$p events were observed. An upper limit of 3 eV, comparable to previous limits, can be placed on the mass difference between the two neutrino eigenstates. The accelerator backgrounds are low and the neutrino fluxes copious so that an experiment to approach a mass difference limit of $\leq$ 1 eV is currently possible. Future experiments with longer distances and larger masses could reach 0.1 eV at the AGS, comparable to the best limits proposed in other accelerator and reactor experiments. 34 references.

41866 Nature of the tau-ν/sub tau/-W coupling. Bacino, W.; Ferguson, T.; Nodulman, L.; Slater, W.E.; Ticho, H.K.; Diamant-Berger, A.; Donaldson, G.; Duro, M.; Hall, A.; Irwin, G.; Kirkby, J.; Merritt, F.; Wojcicki, S.; Burns, R.; Condon, P.; Cowell, P.; Kirz, J. (Physics Department, University of California, Los Angeles, California 90024). *Phys. Rev. Lett.;* 42: No. 12, 749-752(19 Mar 1979).

The electron momentum spectrum observed in the decay tau $\to$ ν/sub tau/eν/sub e/ is in good agreement with the V—A hypothesis. The measured value of the Michel parameter, rho = 0.72 +- 0.15, excludes a V + A current and disfavors pure V or A currents. The spectrum allows us to set an upper limit of 250 MeV/c^2 (95% confidence level) for the tau neutrino mass. Finally, by measuring the tau-lifetime upper limit of 2.3 x 10^{-12} sec (95% confidence level), we show that the square of the coupling constant at the tau-ν/sub tau/-W vertex is at least 12% of full weak strength.

STRONG BARYON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 41826, 41845

41867 (BNL—26002) **Charm particle production by neutrinos.** Samios, N.P. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 18p. (CONF-790150—2). Dep. NTIS, PC A02/MF A01.

From Orbis scientiae 1979 conference; Coral Gables, FL, USA (15 Jan 1979).

Further evidence is discussed, and confirmation given of the existence of the Λ/sub c/$^+$ (2260) and Σ/sub c/$^{++}$ (2424) charm baryons, as well as the observation of the D^{++} (2000) charm meson, these states all being produced by neutrino interactions. Also a brief

review is given of the status of ($\mu^- e^+$) di-lepton neutrino production in bubble chambers, especially as it affects charm production. (JFP)

41868 (COO—2232A-75) **Status report on experiment R-108.** Angelis, A.L.S.; Besch, H.J.; Cool, R.L. (European Organization for Nuclear Research, Geneva (Switzerland); Rockefeller Univ., New York (USA)). 1978. Contract EY-76-C-02-2232. 12p. Dep. NTIS, PC A02/MF A01.

A summary is presented of the status of experiment R-108 at the ISR. Electron pairs and neutral pion transverse momentum are noted. 6 references. (JFP)

41869 **Structure of the high-momentum parts of the deuteron spectra from dd collisions at 4.3, 6.3, and 8.9 GeV/c.** Azhgirei, L.S.; Vzorov, I.K.; Zhmyrov, V.N.; Ivanov, V.V.; Ignatenko, M.A.; Kuznetsov, A.S.; Meshcheryakov, M.G.; Razin, S.V.; Stoletov, G.D.; Tarasov, A.V.; Uzhinskii, V.V. (Joint Institute for Nuclear Research). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 62-64(Jul 1978).

We present experimental data on dd collisions at 4.3, 6.3, and 8.9 GeV/c which exhibit the two-peak structure in the high-momentum parts of the secondary deuteron spectra at momentum transfers vertical-bartvertical-bar$\sim$0.4—0.8 (GeV/c)^2. The results are analyzed using the multiple nucleon-nucleon scattering model. Conclusions are made about the mechanism of elastic and quasielastic dd scattering at the momentum transfers mentioned above.

41870 **How protons are seen by high energy hadrons.** Amaldi, U. (CERN, Geneva, Switzerland). *Sov. Phys. - Usp. (Engl. Transl.);* **21**: No. 4, 328-344(Apr 1978).

A review of the quark model view of the structure of the proton is presented based on pp, πp, p-barp, and kp elastic scattering.

STRONG MESON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 41826, 41867

41871 **Production of muon pairs by 225-GeV/c π^{+-}, K^+, p^{+-} beams on nuclear targets.** Anderson, K.J.; Coleman, R.N.; Hogan, G.E.; Karhi, K.P.; McDonald, K.T.; Newman, C.B.; Pilcher, J.E.; Rosenberg, E.I.; Sanders, G.H.; Smith, A.J.S.; Thaler, J.J. (Enrico Fermi Institute, University of Chicago, Chicago, Illinois 60637). *Phys. Rev. Lett.;* **42**: No. 15, 944-947(9 Apr 1979).

Results are presented from a large-acceptance experiment in which muon-pair production was observed in the mass range 2 to 11 GeV/c^2. Data were taken with π^{+-}, K^+, and p^{+-} beams at 225 GeV/c on carbon, copper, and tungsten targets. Differential cross sections and the production dependence on pair mass, x/sub F/, p/sub T/, incident-particle type, and target nucleus are discussed.

41872 **Observation of the reaction $\pi^- p \to$etaetan at 40 GeV/c.** Apel, W.D.; Augenstein, K.; Bertolucci, E.; Vincelli, M.L.; Donskov, S.V.; Inyakin, A.V.; Kachanov, V.A.; Quaglia, M.; Kittenberger, W.; Krasnokutskii, R.N.; Krueger, M.; Leder, G.; Lednev, A.A.; Mannelli, I.; Mikhailov, Y.V.; Mueller, H.; Pierazzini, G.M.; Prokoshin, Y.D.; Sergiampietri, F.; Sigurdsson, G.; Skribano, A.; Schneider, H.; Steuer, M.; Shuvalov, R.S. (Combined experiment of the Institute of High Energy Physics, Serpukhov, USSR, and the European Organization for Nuclear Research (CERN), Geneva, Switzerland). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 53-54(Jul 1978).

We report the results of an experimental study of the reaction $\pi^- + p \to m\gamma + n$ at the 70-GeV accelerator of the Institute of High Energy Physics. A hodoscopic spectrometer on-line with a computer was used to record γ rays in the final state of the reaction. The reaction $\pi^- p \to$etaetan (eta$\to 2\gamma$) was identified for the first time. In the region of invariant mass of the etaeta system 1600—2800 MeV we have separated a massif of "clean" events free of admixture of $\pi^0\pi^0$ states. The ratio of the cross sections for formation of the final states etaeta and $\pi^0\pi^0$ was found to be $\sim$1:5 in agreement with the quark model. A distinct anisotropy was found in the angular distribution of the etaeta system in the Gottfried-Jackson center-of-mass system for masses above 1600 MeV.

41873 **Study of interactions of π^- mesons with carbon nuclei at momentum 4 GeV/c.** Azimov, S.A.; Gulamov, K.G.; Igamberdiev, K.R.; Inogamov, S.V.; Lipin, V.D.; Lutpullaev, S.L.; Olimov, K.; Usmanov, T.M.; Turdaliev, K.T.; Yuldashev, A.A.; Yuldashev, B.S. (Physico-technical Instutute, Uzbek Academy of Sciences). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 55-58(Jul 1978).

A propane bubble chamber has been used to study the general characteristics of secondary charged pions produced in π^- ^{12}C interactions at 4 GeV/c. From analysis of the experimental data it follows that the inclusive production of π^{+-} mesons is similar in many details to the same type of production at 40 GeV/c.

41874 **Determination of the space—time characteristics of the generation of charged pions in the interaction of π^- mesons and carbon nuclei at 5 GeV/c.** Bairamov, A.A.; Budagov, Y.A.; Valkar, S.; Vinogradov, V.B.; Volod'ko, A.G.; Dvornik, A.M.; Lomakin, Y.F.; Flyagin, V.B.; Kharzheev, Y.N.; Khubua, D.I. (Joint Institute for Nuclear Research). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 59-61(Jul 1978).

The space—time characteristics of the generation of charged pions in π^- ^{12}C interactions at 5 GeV/c is investigated. The obtained dimensions of the interaction region and of the pion emission time are R=2.9 +- 0.08 F and tau= (7.4 +- 3.5) x 10^{-24} sec. These results agree with the data at 3.7 and 40 GeV/c.

41875 **Upper limits for the cross sections of the exclusive reactions $\pi^- + p$ (in a nucleus) $\to$J/psi+n and chi+n at π^--meson momentum 27 and 40 GeV/c.** Golovkin, S.V.; Dzhelyadin, R.I.; Zaitsev, A.M.; Konstantinov, V.F.; Kubarovskii, V.P.; Landsberg, L.G.; Leont'ev, V.M.; Mukhin, V.A.; Obraztsov, V.F.; Petrunina, T.I.; Pokrovskii, N.S. (Institute of High Energy Physics, Serpukhov). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 136(Jul 1978).

After estimating the effective number of protons in the Cu target, the cross sections were compared to those obtained earlier in the NICE apparatus.(AIP)

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

GENERAL

41876 (SLAC-PUB—2294) **Exclusive processes and the exclusive-inclusive connection in quantum chromodynamics.** Brodsky, S.J.; Lepage, G.P. (Stanford Linear Accelerator Center, CA (USA); Cornell Univ., Ithaca, NY (USA). Lab. of Nuclear Studies). Mar 1979. Contract EY-76-C-03-0515. 18p. Dep. NTIS, PC A02/MF A01.

An outline of a new analysis of exclusive processes and quantum chromodynamics is presented. The main elements of this work involve a consistent Fock space decomposition of the hadronic wave function, plus evolution equations for wave functions which allow an exact evaluation of hadronic matrix elements in the asymptotic short distance limit. 77 references. (JFP)

41877 **Feynman rules of quantum chromodynamics inside a hadron.** Lee, T.D. (Columbia University, New York, New York 10027). *Phys. Rev., D;* **19**: No. 6, 1802-1819(15 Mar 1979).

We start from quantum chromodynamics in a finite volume of linear size L and examine its color-dielectric constant κ/sub L/, especially the limit κ/sub infinity/ as L $\to \infty$. By choosing as our standard κ/sub L/ = 1 when L = some hadron size R, we conclude that κ/sub infinity/ must be <1; furthermore, from the fact that a free quark has not been observed we can estimate an upper bound: κ/sub infinity/ $< 1.3 \times 10^{-2}\alpha$ where α is the fine-structure constant of QCD inside the hadron. A permanent quark confinement corresponds to the limit κ/sub infinity/ = 0. The hadrons are viewed as small domain structures (with color-dielectric constant = 1) immersed in a perfect, or nearly perfect, color-dia-electric medium, which is the vacuum. The Feynman rules of QCD inside the hadron are derived; they are found to depend on the color-dielectric constant κ/sub infinity/ of the vacuum that lies outside. We show that, when κ/sub infinity/ $\to$ 0, the mass of any color-nonsinglet state becomes ∞, but for color-singlet states their masses and scattering amplitudes remain finite. These new Feynman rules also depend on the hadron size R. Only at high energy and large four-momentum transfer can such R dependence be neglected and, for color-singlet states, these new rules be reduced to the usual ones.

41878 **Theory of hadronic structure.** Callan, C.G. Jr.; Dashen, R.F.; Gross, D.J. (Princeton University, Princeton, New Jersey 08540). *Phys. Rev., D;* **19**: No. 6, 1826-1855(15 Mar 1979).

We show that the Euclidean vacuum in quantum chromodynamics (QCD) can be regarded as a four-dimensional ensemble of permanent color magnetic dipoles (instantons and meron pairs), with a positive paramagnetic susceptibility. Standard techniques are used to discuss the interactions of this medium for moderate densities. In the presence of color fields (due to quarks), large scale instantons (and other fluctuations) are suppressed, the density is low, and the system is easily treated. Below a critical field strength, this dilute phase is unstable and a first-order phase transition occurs to a dense phase consisting of closely packed instantons and merons, and possibly other things. In this dense phase, we believe that the permeability is infinite (perfect paramagnetism) and thus the normal QCD vacuum cannot tolerate color fields. This leads to a strikingly simple baglike picture of hadrons, as consisting of quarks confined to a region of space-time which is in a very dilute (abnormal) vacuum phase, in equilibrium with the dense vacuum (normal) phase outside the bag. The quarks are confined to the region of dilute phase where

their dynamics are simple; and, as we show, they are shielded from the large-scale fluctuations outside the bag. We present a derivation of the static bag for heavy quarks and an estimate (to within a factor of two) of the bag constant. We further discuss some features of the resulting bag model including chiral-symmetry breaking and surface effects.

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 41889

41879 (AED-Conf—77-656-000, pp 3-20) **Direct electron production measurements by DELCO at SPEAR.** Kirkby, J. (Stanford Linear Accelerator Center, Calif. (USA); Stanford Univ., Calif. (USA). Dept. of Physics). 1977.

From Symposium on lepton and photon interactions at high energies; Hamburg, F.R. Germany (25 Aug 1977).

We have observed weakly-produced electrons in e^+e^- annihilations above Esub(c.m.) approximately 3.75 GeV. In the course of a scan through this threshold region we observed the $^3D_1$ state of charmonium with a mass 3770+-6 MeV/c^2, width GAMMA = 24+-5 MeV and partial width to electron pairs GAMMAsub(ee) = 180+-60 eV. This resonance (named PSI'(3770)) provides a value for the D semileptonic branching ratio of 11+-3%. On the assumption of the Cabibbo nature involved, the PSI' electron momentum spectrum indicates a substantial contribution from the mode D→Kev. A comparison of the events having only two visible prongs (of which only one is an electron) with the heavy lepton hypotheses shows no disagreement. Alternative hypotheses have not yet been investigated.

41880 (BNL—50947, pp 346-374) **Physics with polarized beams: experimental review.** Krisch, A.D. (Univ. of Michigan, Ann Arbor). 1978.

From Workshop on the AGS fixed target research program; Upton, NY, USA (8 Nov 1978).

In high energy physics, discussion of spin effects generally involves proton—proton scattering, that being the area where the best experiments could be performed. Several such experiments are reviewed. (GHT)

41881 (SLAC-PUB—2303) **Meson radiative decays.** Edwards, B.J.; Kamal, A.N. (Alberta Univ., Edmonton (Canada). Dept. of Physics; Stanford Linear Accelerator Center, CA (USA)). Apr 1979. Contract EY-76-C-03-0515. 14p. (CONF-790151—1). Dep. NTIS, PC A02/MF A01.

From Bangladesh physical society meeting; Decca, Bangladesh (14 Jan 1979).

The status of decays of the kind V → Pγ and P → Vγviewed with special emphasis on the work done by the authors in this field. The low experimental value of Γ(rho → πγ) remains the outstanding problem. The lastest preliminary numbers from a Fermi Laboratory experiment go in the right direction but not far enough. 15 references.

41882 **Comparison of muon-pair production to the quark-antiquark annihilation model.** Hogan, G.E.; Anderson, K.J.; Coleman, R.N.; Karhi, K.P.; McDonald, K.T.; Newman, C.B.; Pilcher, J.E.; Rosenberg, E.I.; Sanders, G.H.; Smith, A.J.S.; Thaler, J.J. (Enrico Fermi Institute, University of Chicago, Chicago, Illinois 60637). *Phys. Rev. Lett.;* **42**: No. 15, 948-951(9 Apr 1979).

New data on muon-pair production at 225 GeV/c by π^-, π^+, and proton beams are analyzed with regard to the production mechanism. The observed spin alignment of the pair and the dependence of the cross section on beam-particle type are strong indications that the production is through electromagnetic quark-antiquark annihilation.

41883 **Determination of the pion structure function from muon-pair production.** Newman, C.B.; Anderson, K.J.; Coleman, R.N.; Hogan, G.E.; Karhi, K.P.; McDonald, K.T.; Pilcher, J.E.; Rosenberg, E.I.; Sanders, G.H.; Smith, A.J.S.; Thaler, J.J. (Enrico Fermi Institute, University of Chicago, Chicago, Illinois 60637). *Phys. Rev. Lett.;* **42**: No. 15, 951-955(9 Apr 1979).

Data on muon-pair production by pions are used to determine the momentum distribution for valence quarks in the pion. The shape of a nucleon structure function is also obtained and is compared with a calculation based on existing data.

41884 **Determination of the induced pseudoscalar form factor of the nucleon from an analysis of the reaction $\pi^-p\to e^+e^-n$based on current algebra.** Tkebuchava, F.G. (Joint Institute for Nuclear Research). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 65-66(Jul 1978).

Values of the induced pseudoscalar form factor of the nucleon for invariant momentum transfers -t< or =5m²/sub π/ are obtained from an analysis of experimental data on the process $\pi^-p\to e^+e^-n$. The method is based on the possibility of applying current algebra to describe this process at the "quasithreshold."

41885 **Deep inelastic ep scattering in the region ω≫1.** Bilen'kaya, S.I.; Khristova, E.K. (Joint Institute for Nuclear Research). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 67-70(Jul 1978).

A detailed study is made of deep inelastic ep scattering in the region ω≫1. The analysis of the data in this region shows that it is necessary to introduce a violation of scaling. Parametrizations of the q^2-dependence of the structure functions based on an asymptotically free field theory, on a parton model with non-point-like partons, and on a scale-invariant parton model are considered. It is shown that the available data in this region can be satisfactorily described by all three approaches. A simultaneous analysis of the data on deep inelastic and elastic ep scattering is carried out as a test of the Drell-Yan relation.

41886 **Role of rescattering in electroproduction of cumulative pions.** Braun, M.A.; Vechernin, V.V.; Vlasnikov, A.K. (Leningrad State University). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 71-74(Jul 1978).

The contribution of rescattering by the nucleons of the deuteron in the course of electroproduction of cumulative pions is calculated. In the intermediate state, both multiparticle states (large mass) and single-particle states (small mass) are taken into account. It is shown that, in contrast to the hadron-deuteron collision process, an important role is played in this case by the contribution of the single-particle states to the production of the cumulative pions. Without allowance for the Fermi motion of the nucleons, rescattering can account for the production of cumulative pions with arbitrary value of x, but only if 0<ξ/sub d/<1/2, where x and ξ/sub d/ are the Feynman scale variables for the produced pion and for the initial virtual γ quantum, respectively.

41887 **Effect of electromagnetic mixing on the nucleon mass splitting.** Molchatskii, L.S. (Leningrad Institute of Nuclear Physics, USSR Academy of Sciences). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 87-89(Jul 1978).

Arguments are considered which indicate that the anomalies in the isovector mass differences may be due to the effects of electromagnetic mixing: Aarrow-right-leftΣ⁰, etaarrow-right-leftπ⁰, ωarrow-right-leftrho⁰, etc. As a concrete illustration, the Dashen-Frautschi dispersion method is used to calculate the proton-neutron mass difference. It is shown that: 1) allowance for electromagnetic effects of the usual type leads to the wrong sign for the difference; 2) the ωarrow-right-leftrho⁰ effect plays a dominant role in the nucleon mass splitting; 3) the calculations can be brought into agreement with experiment by adding the ωarrow-right-leftrho⁰ effect to the electromagnetic effects of the usual type.

WEAK INTERACTIONS

41888 (AED-Conf—77-656-000, pp 239-258) **Total cross-sections and mean y from charged current νsub(μ) and anti νsub(μ) collisions.** Barish, B.C.; Bartlett, J.F.; Bodek, A.; Brown, K.W.; Buchholz, D.; Chu, Y.K. (California Inst. of Tech., Pasadena (USA)); Fisk, H.E.; Krafczyk, G.; Nease, D. (Fermi National Accelerator Lab., Batavia, Ill. (USA)); Fackler, O. (Rockefeller Univ., New York (USA)). 1977.

From Symposium on lepton and photon interactions at high energies; Hamburg, F.R. Germany (25 Aug 1977).

New normalized data on νsub(μ) and anti 3nu3sub(μ) interactions, from the Caltech-Fermilab-Rockefeller experiment, are presented. Measurements of small y cross-sections, 1/E dsigma/dy/ y=₀, of total cross-sections sigma/E, and of mean y, <y>, are presented for a set of discrete neutrino energies, E, covering the range 45<E<205 GeV.

41889 (UH—511-295-78) **Processes concerning the number of neutrino types.** Ma, E.; Okada, J. (Hawaii Univ., Honolulu (USA). Dept. of Physics and Astronomy). Jul 1978. Contract EY-76-C-03-0511. 26p. (P). Dep. NTIS, PC A03/MF A01.

The total number N/sub ν/ of neutrino types (ν/sub e/, ν/sub μ/, ν/sub tau/, etc.) is involved in all neutral-current processes in which a ν anti ν pair is produced. Three such processes are examined in detail: $e^+e^-\to\gamma\nu$ anti ν, $K^+\to\pi^+\nu$ anti ν, and K/sub L/ → γν anti ν. It is found that $e^+e^-\to\gamma\nu$ anti ν is especially suited for measuring N/sub ν/, and that the experiment should be feasible at the colliding-beam machines PEP and PETRA. 34 references.

41890 **Electric dipole moment of the quark in a gauge theory with left-handed currents.** Shabalin, E.P. (Institute of Theoretical and Experimental Physics, State Atomic Energy Commission). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 75-77(Jul 1978).

A detailed analysis of the diagrams of a CP non-invariant gauge theory with left-handed charged currents shows that the diagrams of fourth order in a semi-weak coupling constant g give a

vanishing contribution to the electric dipole moment D of the quark in the static limit.

41891 Weak radiative decays of K/sub L/ mesons in a chiral theory. Volkov, M.K. (Joint Institute for Nuclear Research). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 81-82(Jul 1978).

Using pole diagrams with virtual π^0 and eta mesons, the radiative decays of K/sub L/ mesons are expressed in terms of the analogous decays of eta mesons calculated in the single-loop approximation of a chiral field theory. The results are in agreement with the experimental data.

STRONG INTERACTIONS, GENERAL

41892 Interaction of a resonance and a particle in the final state. Polikarpov, M.I. (Institute of Theoretical and Experimental Physics, State Atomic Energy Commission). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 120-124(Jul 1978).

Unitarity relations are derived for the resonance-particle production amplitude and for the resonance-particle scattering amplitude. All the equations are derived for the case when the resonances and particles have arbitrary spins. An approximate analytic solution is obtained of the S-channel unitarity relations, with account taken of right-hand dynamic singularities. By way of example, a correction is obtained for the phase shift of the amplitude of rhoπ production with A_1-meson quantum numbers, due to rhoπ rescattering in the final state. It is shown that rescattering effects necessitate a small incremental phase shift of the production amplitude.

41893 Large transverse momentum processes and the constituent interchange model. Brodsky, S.J.; Blankenbecler, R. (Stanford Linear Accelerator Center, Calif. (USA)); Gunion, J.F. (California Univ., Davis (USA). Dept. of Physics). pp 321-339 of lDeep scattering and hadronic structure. Vol. 2. Tran Thanh Van, J. (ed.). Orsay, France; Universite de Paris-11. Laboratoire de Physique Theorique et Particules Elementaires ([nd]).

From 12. Rencontre de Moriond; Haute-Savoie, France (6 Mar 1977).

The predictions of the constituent interchange model are found to be consistent with the normalization, as well as the scaling laws and angular dependence, of measured large transverse momentum mesons and baryon cross sections. The normalization of the hadronic couplings to valence quarks is computed. Predictions for quantum number correlations between the trigger particles and away side jets are discussed. The predictions of the CIM and quark-quark scattering models are also contrasted.

STRONG INTERACTIONS, BARYON NO.=0

REFER ALSO TO CITATION(S) 41483

41894 Asymptotic bounds for πrho scattering and the A_1 meson. Bolokhov, A.A.; Vereshchagin, V.V. (Leningrad State University). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 133(Jul 1978).

Sum rules are calculated for the coupling constants and masses of resonances in the πrho system.(AIP)

STRONG INTERACTIONS, BARYON NO.=1

REFER ALSO TO CITATION(S) 41895

STRONG INTERACTIONS, BARYON NO. GREATER THAN 1

41895 (BNL—25961) **Properties of the elementary KN and anti KN interactions.** Dover, C.B. (Pennsylvania Univ., Philadelphia (USA); Princeton Univ., NJ (USA)). 1979. Contract EY-76-C-02-0016. 25p. (CONF-790347—8). Dep. NTIS, PC A02/MF A01.

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

Kaon beams offer exciting prospects for the study of both nuclear and hypernuclear physics. Experiments on hypernucleus formation via the (K^-,π^-) reaction, as well as elastic and inelastic scattering of K^{+-} from nuclei, are already underway. The theoretical analysis of such experiments requires an understanding of the underlying two-body K^{+-} n interaction. The main features of these elementary amplitudes, as revealed through phase shift analyses and meson exchange model are reviewed. It is indicated how the properties of the two body interaction (isospin dependence, Y* and Z* resonance formation, strangeness exchange, etc.) are reflected in reactions induced by kaons in nuclei. 81 references.

41896 (ORO—5223-17) **Intermediate-energy nuclear theory. Progress report, July 1, 1978—June 30, 1979.** Bryan, R.A.; VerWest, B.J. (Texas A and M Univ., College Station (USA). Dept. of Physics). Mar 1979. Contract EY-76-S-05-5223. 11p. Dep. NTIS, PC A02/MF A01.

Research carried out during the contract period by R.A. Bryan, principal investigator, and associates R.B. Clark and B.J. VerWest is investigated. The research has centered on the nucleon—nucleon interaction from threshold up through intermediate energies (T/sub L/ $\leq$ 1 GeV). A major portion of time was devoted to the inelastic channel NN $\rightarrow$ NNπ and has resulted in a peripheral model for this reaction which gives good fits to the world data around 800 MeV. The present status of elastic NN scattering above the π-production threshold was reviewed extensively, new parameterizations were developed and data bases assembled for analyses of this process. The three point πNN vertex was studied in the context of the dual Veneziano model where all three particles can be taken off shell. It was shown that this form of off-shell dependence in NN interaction models, hereto ignored, can have important consequences. Finally, initial work was completed in an attempt to use the constituent interchange quark model to constrain the short range behavior of the meson-exchange models of the NN interaction. A list of publications is included.

41897 Polarization in processes with large transverse momentum and in the cumulative production of hadrons. Efremov, A.V. (Joint Institute for Nuclear Research). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 83-86(Jul 1978).

The origin of the polarization of the hadrons in the studied processes is examined in the framework of the hard-collision picture. Assuming that scaling holds, a correct qualitative explanation is given for the dependence of the polarization on p/sub perpendicular/ (or on the emission angle θ in cumulative production). It is predicted that the polarization is independent of energy and weakly dependent on the type of beam and target. A method of measuring the polarization of hadronic jets is proposed.

41898 Hadron-nucleus collisions at asymptotically high energies in the theory of complex angular momenta with α/sub P/$^0>1$. Grigoryan, L.A.; Shakhbazyan, V.A. (Erevan Physics Institute). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 90-92(Jul 1978).

It is shown that the hadron-hadron and hadron-nucleus total cross sections are asymptotically equal in the eikonal approximation in the theory of complex angular momenta with α/sub P/$^0>1$.

41899 Some multi-particle correlations in pp interactions at 69 GeV/c and their interpretation in the multi-cluster model. Boos, E.G.; Dremin, I.M.; Lukin, E.S.; Orlov, A.M. (Institute of High Energy Physics, Kazakh Academy of Sciences). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 96-99(Jul 1978).

A study is made of the relationship between the average values of the rapidities and their dispersions in individual interactions and of the distribution of rapidity gaps in pp interactions at 69 GeV/c, and the results are compared with the multiperipheral cluster model. While qualitative agreement is observed, there are a number of discrepancies which suggest further modifications of the model (in particular, changes in the cluster parameters).

PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES

GENERAL

41900 Vacuum instability and new constraints on fermion masses. Hung, P.Q. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev. Lett.;* **42**: No. 14, 873-876(2 Apr 1979).

I show that, in the Weinberg-Salam model with one Higgs doublet, in order for the physical vacuum to be an absolute minimum (in the one-loop approximation), certain requirements on the fermion masses have to be met. Specifically, the quantity {summation/sub i/ m/sub f/i^4}/sup 1/4/, where the summation extends over fermions, is bounded from above by approximately 133.5 GeV ($\sin^2\theta$/sub W/ = 0.25) or 137.7 GeV ($\sin^2\theta$/sub W/ = 0.2).

41901 Quantum fluctuations of instantons in the nonlinear O (3) σ-model. Kafiev, Y.N. (Mathematics Institute, Siberian Division, USSR Academy of Sciences). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 115-119(Jul 1978).

The fluctuation spectra of the one-instanton solution have been calculated in the limit when the distance between centers tends to zero and infinity, respectively, in the nonlinear O (3) σ-model. The integration measure has been obtained in terms of the subtracted coupling constant.

APPLICATIONS TO ELECTROMAGNETIC AND WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 41819, 41844, 41910

41902 (UH—511-296-78) **Gauge model of parity nonconservation in neutral-current phenomena.** Ma, E.; Pramudita, A.; Tuan, S.F.

(Hawaii Univ., Honolulu (USA). Dept. of Physics and Astronomy). Jul 1978. Contract EY-76-C-03-0511. 12p. Dep. NTIS, PC A02/MF A01.

A unified weak-electromagnetic gauge model is proposed based on SU(2) x U(1) x U(1) to explain the apparent conflict between the null results of the atomic bismuth experiments and the affirmative result of the polarized electron—deuterium experiment with regard to parity nonconservation in neutral-current phenomena. 12 references.

41903 $\Delta T=1/2$ rule in quark models with physical color. Arbuzov, B.A.; Kompaneets, V.G.; Tikhonin, F.F. (Institute of High Energy Physics, Serpukhov). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 93-95(Jul 1978).

The hadronic weak current is constructed in the three-triplet quark model with observable color. The current has the following properties: a) it satisfies the weak SU (2) algebra; b) the neutral current is completely diagonal and coincides with the electromagnetic current in the quark structure; c) the (white) part of the current has the properties of the Gabibbo current. The features of the colorless part of the nonleptonic Lagrangian obtained from this current are as follows: a) the ratio of the coefficients of the amplitudes of transitions with $\Delta T=1/2$ and $\Delta T=3/2$ is ~ 25, which coincides with the experimental value; b) there are no transitions with $\Delta S=2$; c) the magnitudes of the amplitudes of transitions with $\Delta T=0$, 1, and 2 with no change of strangeness are comparable.

APPLICATIONS TO STRONG INTERACTIONS

41904 (UPR—0114T) Strong CP invariance with new massless quarks. Chang, L.N.; Barr, S.M.; Kim, J.E. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA). Dept. of Physics; Pennsylvania Univ., Philadelphia (USA). Dept. of Physics). 1978. Contract EY-76-C-02-3071. 11p. Dep. NTIS, PC A02/MF A01.

New massless quarks Q_1 and Q_2 transforming nontrivially in an additional gauge group G are postulated to solve the strong CP problem naturally. 19 references.

41905 (UPR—0116T) Echo hadrons: color confinement and fractionally charged states. Zee, A. (Pennsylvania Univ., Philadelphia (USA). Dept. of Physics). 16 Jan 1979. Contract EY-76-C-02-3071. 13p. Dep. NTIS, PC A02/MF A01.

It is speculated that the gauge group of strong interaction is larger than SU(3). As a consequence, fractionally charged states can become liberated. 18 references.

41906 Analysis of representations of the SU (4, 1) group of hadron dynamical symmetry and the masses of charmed particles. Gavrilik, A.M.; Shirokov, V.A. (Institute of Theoretical Physics, Academy of Sciences of the Ukrainian SSR). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 100-103(Jul 1978).

All representations of the SU (4, 1) group which are determined by integral parameters and describe $(1/2)^+$ baryons and 0^- mesons are analyzed within the framework of the hadron dynamical SU (4, 1) symmetry model. Using the formula for the mass operator proposed in the present study, it is shown that out of all the representations of this type of SU (4, 1) group only four can be used to describe the mass spectrum of 0^- mesons. The mass formulas are obtained in these four representations and the masses of the charmed 0^- mesons are calculated. The requirement that the representation describing $(1/2)^+$ baryons be contained, in addition to several of the four representations describing 0^- mesons, in a single representation of the principle nonunitary series of the SU (4, 1) group serves as the criterion for choosing a baryon representation and allows it to be fixed. The mass formulas are obtained and the masses of the charmed $(1/2)^+$ baryons are calculated in this representation.

41907 Superoperators in the dual model with colored quarks. Manida, S.N. (Leningrad State University). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 108-109(Jul 1978).

The dual model with colored quarks is rewritten as a superoperator generalization of the Bardakci-Halpern model. It is shown that the three-Reggeon vertex in the dual model with colored quarks can be written in a clear and compact form.

FIELD THEORY

REFER ALSO TO CITATION(S) 41876

41908 (AED-Conf—77-656-000, pp 895-910) Quantum chromodynamics. Susskind, L. (Stanford Linear Accelerator Center, Calif. (USA)). 1977.

From Symposium on lepton and photon interactions at high energies; Hamburg, F.R. Germany (25 Aug 1977).

Quantum chromodynamics is a comprehensive theory of colored quarks interacting with colored gluons. We believe it is a correct theory of strong interactions largely because any other quantum field theory seems to be inconsistent with one or more of the general features of hadron physics discovered over the past 15 years. In this review I am not going to discuss QCD from the mathematical or formal point of view. I will mainly concentrate on those features of the theory which seem to me most critical in testing it.

41909 (COO—1545-252) Anomalies, unitarity and renormalization. Frampton, P.H. (Ohio State Univ., Columbus (USA). Dept. of Physics). 1978. Contract EY-76-C-02-1545. 8p. (CONF-790150—1). Dep. NTIS, PC A02/MF A01.

From Orbis scientiae 1979 conference; Coral Gables, FL, USA (15 Jan 1979).

It is indicated how renormalizability of a gauge theory with γ_5 couplings to fermions can require additional dynamical constraints to those already well known in connection with the triangle anomaly. An outline of differences from previous work is given. 11 references. (JFP)

41910 (UPR—0106T) Instanton enhancement of $\Delta I = 1/2$ nonleptonic interactions. Kim, J.E. (Pennsylvania Univ., Philadelphia (USA). Dept. of Physics). 1978. Contract EY-76-C-02-3071. 15p. Dep. NTIS, PC A02/MF A01.

It is found that an effect of the instanton solutions of QCD is an enhancement of $\Delta I = 1/2$ nonleptonic interactions. The dominant determinantal interaction of light quarks due to instantons chooses only antisymmetrical color indices of anti u and anti d from anti dγ/sub $\mu/(1+\gamma_5)$u anti uγ/sub $\mu/(1+\gamma_5)$s. 19 references.

41911 TP inversion in quantum gravity. Perry, M.J. (Institute for Advanced Study, Princeton, New Jersey 08540). *Phys. Rev., D;* **19**: No. 6, 1720-1731(15 Mar 1979).

We discuss the Eguchi-Hanson instanton in depth. Initially we describe its relevance to quantum gravity and how it fits into the classification of gravitational instantons. We then construct Green's functions in the instanton background. We apply the ideas discussed to scattering theory and describe some examples. We conclude with some speculations and a discussion of the meaning of more complex members of a family of instantons of which this is the first.

41912 Little-group classification of gauge fields. Castillejo, L.; Kugler, M.; Roskies, R.Z. (Institute for Theoretical Physics, State University of New York at Stony Brook, Stony Brook, New York 11794). *Phys. Rev., D;* **19**: No. 6, 1782-1790(15 Mar 1979).

We propose a new way to treat the classification of the Yang-Mills gauge fields at one space-time point. Our main tool is to consider the structure of the little group which leaves the field invariant. This approach reproduces the standard classification of the Weyl tensor and of the electromagnetic field.

41913 Strong-coupling expansion in quantum field theory. Bender, C.M.; Cooper, F.; Guralnik, G.S.; Sharp, D.H. (Department of Physics, Washington University, St. Louis, Missouri 63130). *Phys. Rev., D;* **19**: No. 6, 1865-1881(15 Mar 1979).

We derive a simple and general diagrammatic procedure for obtaining the strong-coupling expansion of a d-dimensional quantum field theory, starting from its Euclidean path-integral representation. At intermediate stages we are required to evaluate diagrams on a lattice; the lattice spacing provides a cutoff for the theory. We formulate a simple Pade-type prescription for extrapolating to zero lattice spacing and thereby obtain a series of approximants to the true strong-coupling expansion of the theory. No infinite quantities appear at any stage of the calculation. Moreover, all diagrams are simple to evaluate (unlike the diagrams of the ordinary weak-coupling expansion) because nothing more than algebra is required, and no diagram, no matter how complex, generates any transcendental quantities. We explain our approach in the context of a gphi^4 field theory and calculate the two-point and four-point Green's functions. Then we specialize to d = 1 (the anharmonic oscillator) and compare the locations of the poles of the Green's functions with the tabulated numerical values of the energy levels. The agreement is excellent. Finally, we discuss the application of these techniques to other models such as gphi/sup 2N/, g (psi-barpsi)^2, and quantum electrodynamics.

41914 Conformal invariance in elementary particle physics. Dyc, D.V. (Institute of Physics, Hanoi). *Sov. J. Particles Nucl. (Engl. Transl.);* **9**: No. 5, 410-420(Sep 1978).

Some aspects of conformal invariance in elementary particle physics are considered: the laws of conformal transformations of fields, the conformally covariant two-point and three-point functions, the dimensional properties of the energy-momentum tensor, the mass radius of the pion, the $\sigma\pi\pi$ vertex, and the connection between scale and chiral invariance.

41915 Investigation of gauge theories in the strong coupling regime by the Lipatov method. Ushveridze, A.G. (Physics Institute, Georgian Academy of Sciences). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 110-112(Jul 1978).

A power-law growth of the invariant charge at large distances is obtained in quantum chromodynamics on the basis of a somewhat modified Lipatov method.

41916 Restoration of spontaneously broken symmetry in a magnetic field. Skalozub, V.V. (Dnepropetrovsk State University). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 113-114(Jul 1978).

It is shown that there is no restoration of spontaneously broken non-Abelian symmetry in a magnetic field when massive charged vector mesons are taken into account. The analogy with the Ginzburg-Landau theory of superconductivity disappears for vector particles with an anomalous magnetic moment $\kappa > 0$. Instead of the phase transition into the symmetric state the creation of massive vector particles b^+b^- in the nonsymmetric vacuum takes place.

41917 Calculation of the Gell-Mann—Low function in scalar field theory. Eletskii, V.L.; Popov, V.S. (Institute of Theoretical and Experimental Physics, State Commission on the Use of Atomic Energy). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 134-135(Jul 1978).

The Pade-Borel method is used to calculate the Gell-Mann—Low function with the interaction $g0^4/4$.(AIP)

41918 Signal velocity in quantum electrodynamics. Shirokov, M.I. (Joint Institute for Nuclear Research, Dubna (Moscow Region)). *Sov. Phys. - Usp. (Engl. Transl.);* **21**: No. 4, 345-358(Apr 1978).

The fulfillment in quantum electrodynamics of the principle of relativistic causality: the signal velocity does not exceed the velocity of light: is discussed. In Sec. 1 it is argued that this principle is not guaranteed automatically merely by the local commutativity of the theory. Section 2 is a critical review of the signal transmission problems which have been formulated and solved in the literature. In Sec. 3, this problem is considered in the framework of a simple but fairly realistic model of quantum electrodynamics. The signal source is an external current localized in some region S. The arrival of a signal in a region D at a distance R is established by a change in the coordinate, momentum, or energy of a charged particle. It is shown that proof of relativistic causality of the theory requires one to take into account appropriately quantum-mechanical and, in particular, quantum-electrodynamical features of the problem. In the final fourth section, a general formulation and exact solution of the signal transmission problem are given. The treatment is of sufficient generality for one to be able to assert that in the framework of quantum electrodynamics none of the possible methods of signal transmission violate relativistic causality.

SCATTERING THEORY

41919 (ORO—3992-351) **Unstable quantum states and rigged Hilbert spaces.** Gorini, V.; Parravicini, G. (Texas Univ., Austin (USA). Dept. of Physics). Oct 1978. Contract EY-76-S-05-3992. 11p. (CONF-781088—1). Dep. NTIS, PC A02/MF A01.

From 7. international colloquium on group theoretical methods in physics; Austin, TX, USA (14 Sep 1978).

Rigged Hilbert space techniques are applied to the quantum mechanical treatment of unstable states in nonrelativistic scattering theory. A method is discussed which is based on representations of decay amplitudes in terms of expansions over complete sets of generalized eigenvectors of the interacting Hamiltonian, corresponding to complex eigenvalues. These expansions contain both a discrete and a continuum contribution. The former corresponds to eigenvalues located at the second sheet poles of the S matrix, and yields the exponential terms in the survival amplitude. The latter arises from generalized eigenvectors associated to complex eigenvalues on background contours in the complex plane, and gives the corrections to the exponential law. 27 references.

PHYSICS RESEARCH (CONT.)

NUCLEAR PHYSICS

41920 (ORO—1667-17) **Triangle Universities Nuclear Laboratory annual report: TUNL XVII, 1 January—31 December 1978.** (Duke Univ., Durham, NC (USA); North Carolina Univ., Chapel Hill (USA); North Carolina State Univ., Raleigh (USA)). 1978. Contract EY-76-C-05-1067. 146p. Dep. NTIS, PC A07/MF A01.

The major emphasis of the work was on light ion-induced nuclear reactions particularly those initiated by polarized beams of protons and deuterons, and elastic and inelastic scattering with high-resolution beams. Extensive work was also done in the fields of ion source development and neutron physics. The report is organized as follows: neutron and fission physics, neutron polarization studies, high-resolution studies, gamma-ray spectroscopy, charged-particle reactions with polarized beams, radiative capture reactions, atomic physics, heavy-ion physics, applications, ion source development, accelerator development and instrumentation, computer-related development, and nuclear theory and phenomenology. Lists of journal articles, reports, seminars, etc., are given in an appendix. Eleven items with significant information are abstracted and indexed individually. (RWR)

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

41921 Differential fragmentation cross sections for 7.3 GeV nitrogen ions incident on protons. Wefel, J.P.; Kidd, J.M.; Schimmerling, W.; Vosburgh, K.G. (Laboratory for Cosmic Ray Physics, Naval Research Laboratory, Washington, D. C. 20375). *Phys. Rev., C;* **19**: No. 4, 1380-1392(Apr 1979).

Differential cross sections $d\sigma/d\Omega$ for the inclusive reaction $^{14}N + p \rightarrow Z +$ anthing (for $3 < \text{or} = Z < \text{or} = 6$) have been measured at six laboratory production angles ($\theta < 5°$) for 7.3 GeV nitrogen ions interacting in liquid hydrogen. The angular distributions for C, B, and Be fragments decrease sharply with increasing angle, as expected for this type of peripheral reaction. The corresponding transverse momentum (p/sub t/) distributions for these fragments can be represented by Gaussian functions of p/sub t/. The Li distribution appears to be non-Gaussian, suggesting one (or more) different production mechanisms. The dependence of the widths of the momentum distributions on fragment mass is not consistent with theoretical predictions, and shows some evidence for an "effective" number of nucleons which determine the fragmentation spectrum of the nitrogen nucleus. Integration of the angular distributions gives partial production cross sections which are consistent with results at higher energy. This energy-independent behavior implies that limiting fragmentation is applicable down to energies of 0.5 GeV/nucleon.

41922 Role of spin-isospin effects in the π^3He scattering problem in the region of the Δ (1236) resonance. Galimzyanov, R.M.; Isaev, V.P.; Musakhanov, M.M. (Tashkent State University). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 104-107(Jul 1978).

The π^3He scattering amplitude near the Δ (1236) resonance is obtained in the "frozen" nucleon approximation with account taken of all the pion-rescattering multiplicities. It is shown that allowance for the spin and the isospin leads to a fast convergence of the multiple-scattering series. The off-mass-shell behavior of the πN amplitude and the repulsion between the nucleons are considered.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19 THEORETICAL

ENERGY LEVELS AND TRANSITIONS

41923 Deformation of spectrum of ^{6}Li nucleus under compression. Bursak, A.V.; Verzhbitskii, V.V.; Gorbatov, A.M.; Krylov, Y.N.; Solovei, A.B.; Shein, Y.L. (Kalinin State University). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 19-20(Jul 1978).

The low-lying positive-parity energy levels of ^{6}Li are calculated with the realistic GPT potential in the principal approximation of the hyperspheric-function method. It turns out that the sequence of the second and third levels is the opposite of that given by experiment. The change of the level positions following weak compression of the ^{6}Li nucleus is studied. To obtain the correct sequence of the first six levels it suffices to decrease the rms radius by merely 0.1 F.

NUCLEAR REACTIONS AND SCATTERING

41924 Kaon inelastic scattering and charge exchange on nuclei. Dover, C.B.; Walker, G.E. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **19**: No. 4, 1393-1407(Apr 1979).

We present the results of calculations of kaon inelastic and charge exchange reactions on nuclei, based on the microscopic particle-hole shell model. Both K^+ and K^- inelastic scattering on ^{12}C are discussed for incident momenta p/sub lab/ = 300 MeV/c and 800 MeV/c. In addition, we examine the charge exchange process

$^{30}Si(K^-,K\text{-bar}^0)^{30}Al$ at 300 MeV/c. We employ the distorted wave impulse approximation, using a transition operator constructed from free space K^{+-}-nucleon amplitudes taken from analyses of two-body data. For the off-shell extrapolation of the two-body t matrix, required in the many-body problem, we use a separable form factor obtained by solving the inverse scattering problem. The inelastic scattering results are found to be insensitive to the presence of the off-shell form factor. We find that normal parity T = 0 and 1 states dominate the nuclear response to both K^+ and K^-. At 300 MeV/c, some qualitative differences in the inelastic scattering predictions arise from choosing different elementary amplitudes from the literature. Thus kaon-nucleus scattering may shed some light on ambiguities in the low energy free space interactions of kaons. At 800 MeV/c, there is much less uncertainty in the two-body t matrix, so we can focus our attention on nuclear structure aspects. We compare the kaons with pions, electrons, protons, and α in terms of their inelastic scattering and charge exchange properties. By emphasizing nuclear structure aspects such as the excitation of high spin states and the splitting of the T/sub less-than/ and T/sub greater-than/ components of giant resonances, we show that kaons are very promising as a nuclear probe.

41925 Theory of photodisintegration of the ^{12}C nucleus into three α particles in the hyperspherical basis. Dzhibuti, R.I.; Krupennikova, N.B.; Tomchinskii, V.Y. (Physics Institute, Georgian Academy of Sciences). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 15-18(Jul 1978).

A computation scheme for the reaction $\gamma + {}^{12}C \rightarrow 3\alpha$ is developed within the framework of the three-α-particle model of the ^{12}C nucleus using a basis of hyperspherical functions in the momentum representation. The proposed method makes it possible to take into account interactions between all the α particles in both the initial and final states. It is shown that if the one-α-particle mechanism of γ-quantum absorption is proposed, than allowance for the interaction at the end of the reaction leads to a substantial change in the results of the plane-wave approximation, namely, the reaction cross section decreases by two orders of magnitude. On the other hand, in the case of the two-α-particle absorption mechanism this interaction leads to a qualitative change in the cross-section curve, wherein the maximum of the cross section becomes narrow. The results of the calculations lead to the conclusion that the three-α-particle photodisintegration of the ^{12}C nucleus proceeds mainly via the mechanism of two-α-particle quadrupole absorption of the gamma quanta. This conclusion agrees with preliminary data of recent experiments.

41926 Effect of optical-model parameters on spectroscopic information obtained from (p,d) reactions. Mazitov, B.S.; Radyuk, G.A.; Rasulov, E.N.; Yarmukhamedov, R. (Nuclear Physics Institute, Academy of Sciences of the Uzbek SSR). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 33-34(Jul 1978).

We have investigated the stability of nuclear vertex constants relative to constants in the optical potentials used to calculate the distorted wave functions for the entrance and exit channels. The calculations were performed using the modified distorted-wave method and the peripheral model, and the angular distributions of deuterons from (p,d) reactions on ^{13}C and ^{14}N are used as examples.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 41933

41927 (ORO—4699-T1) **Study of the two body dissociation of light nuclei in nuclear fields. Progress report, January 1, 1978—June 30, 1979.** Kirk, P.N.; Huggett, R.W. (Louisiana State Univ. and Agricultural and Mechanical Coll., Baton Rouge (USA)). 1979. Contract EY-76-S-05-4699. 5p. Dep. NTIS, PC A02/MF A01.

A summary of research is presented on the extent of nuclear clustering in lithium 6 in the reactions $^6Li + X \rightarrow {}^4He + {}^2H + X$ and $^3He + {}^3H + X$ at 11.8 GeV. A list of publications is included. (JFP)

41928 Angular distributions of the $^6Li(n,t)^4He$ and $^{10}B(n,\alpha)^7Li$ reactions at 2 and 24 keV. Stelts, M.L.; Chrien, R.E.; Goldhaber, M.; Kenny, M.J.; McCullagh, C.M. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **19**: No. 4, 1159-1167(Apr 1979).

The angular distributions of charged particles from the $^6Li(n,t)^4He$ and $^{10}B(n,\alpha)^7Li$ were measured with monoenergetic neutron beams from a reactor. Silicon surface barrier detectors were used. The $^6Li(n,t)^4He$ data were compared with previous results having poorer angular resolution and with an R-matrix calculation. The $^{10}B(n,\alpha)^7Li$ data show a marked anisotropy at 2 and 24 keV for the ground state group and a lesser anisotropy for α's leading to the first excited state of ^7Li. Branching ratios are measured at thermal, 2- and 24-keV neutron energies. The results are compared with the R-matrix calculation.

41929 Influence of extra neutrons added to the $^{12}C + {}^{16}O$ system: Gross structures in γ-ray yields following the $^{13}C + {}^{16}O$ and $^{12}C + {}^{18}O$ reactions. Chan, Y.; Bohn, H.; Vandenbosch, R.; Sielemann, R.; Cramer, J.G.; Bernhardt, K.G.; Bhang, H.C.; Chiang, D.T.C. (Nuclear Physics Laboratory, University of Washington, Seattle, Washington 98195). *Phys. Rev. Lett.;* **42**: No. 11, 687-690(12 Mar 1979).

Excitation functions for the dominant fusion channels in the $^{13}C + {}^{16}O$ and $^{12}C + {}^{18}O$ reactions have been measured from 7 to 25 MeV (c.m.) using γ-ray spectroscopy. Comparison with the $^{12}C + {}^{16}O$ system shows that gross structure persists in the α-out channel for $^{13}C + {}^{16}O$ but is not apparent in this channel for $^{12}C + {}^{18}O$, although observed in the inelastic channels for the latter. $^{13}C + {}^{16}O$ is the first system not comprised of α-cluster nuclei to exhibit gross structures in fusion channels.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 41929

41930 (ORO—1667-17, pp 8-9) **Fast neutron cross sections: oxygen 16.** Walter, R.L. (Duke Univ., Durham, NC); Gould, C.R.; Purser, F.O. 1978.

In Triangle Universities Nuclear Laboratory annual report: TUNL XVII, 1 January—31 December 1978.

Differential elastic scattering cross sections over most of the angular range are presented for energies from 9.211 to 14.933 MeV. 1 figure. (RWR)

41931 (ORO—1667-17, pp 20-24) **Cross-section measurements for $^9Be(p,n)^9B$, $^{15}N(p,n)^{15}O$ and $^{13}C(p,n)^{13}N$.** Byrd, R.C.; Murphy, K.; Guss, P.; Floyd, C.; Walter, R.L. (Duke Univ., Durham, NC). 1978.

In Triangle Universities Nuclear Laboratory annual report: TUNL XVII, 1 January—31 December 1978.

Angular distributions are presented and compared over the approximate energy range from 10 to 16 MeV. 4 figures. (RWR)

41932 (ORO—1667-17, pp 45-52) **$^{13}C(\text{anti p}, \gamma_0)^{14}N$ reaction.** Turner, J.D. (Duke Univ., Durham, NC); Roberson, N.R.; Wender, S.A.; Manglos, S.H.; Weller, H.R.; Jensen, M.J.; Tilley, D.R. 1978.

In Triangle Universities Nuclear Laboratory annual report: TUNL XVII, 1 January—31 December 1978.

90^0 excitation functions and angular distribution coefficients are plotted over the approximate range 7 to 17 MeV. The data are analyzed for capture amplitudes and phases. 8 figures. (RWR)

41933 (ORO—1667-17, pp 57-60) **Study of the GDR in ^{15}N using fast neutron capture.** Wender, S.A. (Duke Univ., Durham, NC); Jensen, M.; Potokar, M.; Roberson, N.R.; Tilley, D.R.; Weller, H.R. 1978.

In Triangle Universities Nuclear Laboratory annual report: TUNL XVII, 1 January—31 December 1978.

The detailed-balance principle was used on $^{14}N(n,\gamma)$ data to produce the $^{15}N(\gamma,n)$ excitation function from 14 to 24 MeV. [Similar results for $^{15}N(\gamma,p)$ and $^{15}O(\gamma,p)$ are also shown]. a_2 angular distribution coefficients are plotted for the three capture reactions. The details of the reaction mechanism are discussed. 2 figures. (RWR)

41934 Resonances in electron scattering by ^{10}B and ^{12}C. Shevchenko, N.G.; Buki, A.Y.; Mazan'ko, B.V.; Polishchuk, V.N.; Khomich, A.A. (Khar'kov Physico-technical Institute, Ukrainian Academy of Sciences). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 5-6(Jul 1978).

Energy spectra of 140-MeV electrons are measured after scattering by ^{10}B and ^{12}C nuclei. Peaks above the nucleon emission threshold are observed in the ^{10}B spectra at energies 8.26, 9.0, and 9.7 MeV, and at 18.1 MeV in the ^{12}C spectra. The existence of these peaks and their energy location is predicted by calculations based on inclusion of the contribution of triangle Feynman diagrams to the reaction amplitude.

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 41937

41935 (LBL—8965) **Nuclear structure from continuum γ-rays.** Diamond, R.M. (California Univ., Berkeley (USA). Lawrence

Berkeley Lab.). Mar 1979. Contract W-7405-ENG-48. 24p. (CONF-790323—4). Dep. NTIS, PC A02/MF A01.

From Symposium on high spin phenomena in nuclei; Argonne, IL, USA (15 Mar 1979).

The properties of states of spins of 20 to 60 are considered using the liquid-drop model and some shell effects. The angular momenta at which the fission barrier becomes zero or 8 MeV as a function of mass number, moments of inertia and rotational energies and the various gamma spectra for some specific nuclei are plotted. 15 references. (JFP)

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 41935

41936 (ORO—1667-17, pp 68-70) **Direct—semidirect model analysis of $^{30}Si(p,\gamma_1)$ in the region of the isovector giant quadrupole resonance.** Potokar, M. 1978.

In Triangle Universities Nuclear Laboratory annual report: TUNL XVII, 1 January—31 December 1978.

Results of model calculations for the excitation function and a_3 coefficient are shown over the range 7 to 27 MeV. The data presented here are the first firm evidence of the isovector quadrupole resonance in this mass region. 2 figures. (RWR)

41937 (ORO—1667-17, pp 71-72) **Giant dipole resonance built on the ground and the first excited state of ^{31}P.** Potokar, M. 1978.

In Triangle Universities Nuclear Laboratory annual report: TUNL XVII, 1 January—31 December 1978.

The energy-averaged cross section for $^{30}Si(p,\gamma_{0\ 1})$ reactions from 5 to 27 MeV is compared with direct—semidirect model calculations. 1 figure. (RWR)

41938 (ORO—1667-17, pp 72-73) **Calculation of angular distribution coefficients for $^{30}Si(p,\gamma_0)$ by the DSD model.** Potokar, M. 1978.

In Triangle Universities Nuclear Laboratory annual report: TUNL XVII, 1 January—31 December 1978.

Direct—semidirect model calculations of a/sub k/ and b/sub k/ coefficients are compared with experimental data from 6 to 15 MeV. 1 figure. (RWR)

41939 **Evidence for a blast wave from compressed nuclear matter.** Siemens, P.J.; Rasmussen, J.O. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **42**: No. 14, 880-883(2 Apr 1979).

Central collisions of heavy nuclei at c.m. kinetic energies of a few hundred MeV per nucleon produce fireballs of hot, dense nuclear matter. Each fireball explodes, producing a blast wave of nucleons and pions. Several features of the observed cross sections for pions and protons from Ne on Na F at 0.8 GeV/nucleon (lab) are explained by the blast wave, but contradict earlier, purely thermal models. The available energy is equally divided between translational energy of the blast, and thermal motion of the particles in the exploding matter.

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 41937

41940 (IAEA—208(Vol.1), pp 361-373) **Status of some activation cross sections for reactor neutron dosimetry in the range 13-15MeV.** Vonach, H. (Oesterreichische Akademie der Wissenschaften, Vienna. Inst. fuer Radiumforschung und Kernphysik). 1978.

From Consultants meeting on integral cross section measurements in standard neutron fields; Vienna, Austria (15 Nov 1976).

The following aspects of the problem are discussed: The accuracy obtainable at present in activation cross section measurement around 14MeV neutron energy; the present status of the activation cross sections in general and as specific examples the status of the following reactions: $^{27}Al(n,\alpha)$, $^{56}Fe(n,p)$, $^{63}Cu(n,2n)$ ^{64}Cu; what should be done to further improve the situation.

41941 **Reactions $(n,n'\gamma)$, (n,np), and (n,pn) in ^{23}Na, ^{27}Al, and ^{32}S at a neutron energy 14.6 MeV.** Kozy, Y.E.; Prokopets, G.A. (Kiev State University). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 7-11(Jul 1978).

The spectra of neutrons with initial energy 14.6 MeV inelastically scattered by the nuclei ^{23}Na, ^{27}Al, and ^{32}S have been measured in coincidence with energetic prompt γ rays. Differential cross sections for inelastic scattering are obtained, and also the differential cross sections for the neutron yield. Radiative decay of states with an unbound proton is responsible for 300 mb in the inelastic scattering cross section for ^{23}Na, 400 mb for ^{27}Al, and 110 mb for ^{32}S with a total $(n,n'\gamma)$ cross section respectively 560, 580, and 270 mb. Cross sections are given for the reactions (n,np) and (n,pn). A calculation of the cross sections according to a statistical model systematically taking into account angular momentum does not give complete agreement with experiment. The observed deviations can be explained by the dominance of certain single-particle configurations in the highly excited nucleus immediately before nucleon emission.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 41935

41942 **Model for an effective Q value for heavy-ion—induced transfer reactions.** Seglie, E.A.; Petersen, J.F.; Ascuitto, R.J. (A. W. Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06520). *Phys. Rev. Lett.;* **42**: No. 15, 956-959(9 Apr 1979).

A model is presented which accounts for the shifts in the energy levels of a transferred nucleon due to the proximity of the colliding ions during the reaction process. Including these shifts through an effective Q value in a distorted-wave Born-approximation formalism leads to dramatic improvement of the calculated angular distributions for the reactions induced by 56-MeV ^{16}O on ^{48}Ca.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 41935

41943 **Investigation of the contribution of direct processes to reactions with three particles in the final channel.** Ezhov, S.N.; Plyuyko, V.A. (Kiev State University). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 40-43(Jul 1978).

The problem of nucleon knockout is studied in the three-body approximation. An integral equation describing this process is obtained and a class of potentials for which the equation is of the Fredholm type is found. The distorted-wave, T-matrix, and Born approximations are obtained and compared on this basis. We calculate σ (n,2n) for the nuclei ^{54}Fe, ^{56}Fe, and ^{59}Co, the second-neutron spectrum for $^{59}Co(n,2n)$, and the neutron angular correlations in the reaction $^{208}Pb(n,2n)$.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 41940

41944 (ORO—1667-17, pp 63-65) **Study of the $^{40}Ca(anti\ n,\gamma_0)^{41}Ca$ reaction.** Jensen, M.J. (Duke Univ., Durham, NC); Wender, S.A.; Clegg, T.B.; Potokar, M.; Roberson, N.R.; Tilley, D.R.; Weller, H.R. 1978.

In Triangle Universities Nuclear Laboratory annual report: TUNL XVII, 1 January—31 December 1978.

Preliminary data on the angular distribution of the analyzing power measurements at 9.0 and 11.0 MeV are given, along with the energy dependence of the analyzing-power angular distribution coefficient and the results of a direct—semidirect calculation. 2 figures. (RWR)

41945 **Fragmentation of relativistic ^{56}Fe.** Westfall, G.D.; Wilson, L.W.; Lindstrom, P.J.; Crawford, H.J.; Greiner, D.E.; Heckman, H.H. (Lawrence Berkeley Laboratory and Space Sciences Laboratory, University of California, Berkeley, California 94720). *Phys. Rev., C;* **19**: No. 4, 1309-1323(Apr 1979).

The fragmentation of ^{56}Fe at 1.88 GeV/nucleon has been studied on H, Li, Be, C, S, Cu, Ag, Ta, Pb, and U targets. The detection apparatus consisted of a simple transmission detector. A method is presented which eliminates the effects of multiple interactions in the targets which were typically half an interaction-length thick. Elemental production cross sections, σ (Z), were measured for Z = 13 to 25. Measured charge-changing cross sections, σ/sub DeltaZ/ > or = 1, and derived mass-changing cross sections, σ/sub DeltaA/ > or = 1, are presented for each target. The σ (Z) factor into a term which depends only on the target and a term which depends only on the fragment observed. The σ/sub DeltaZ/ > or = 1 and σ/sub DeltaA/ > or = 1 follow a simple geometric

behavior. The cross section for the removal of one proton from the ^{56}Fe projectile is enhanced for the heavier targets. This effect is described by a model assuming Coulomb dissociation. The σ (Z) for ^{56}Fe on the H target are compared to the semiempirical formulas of Silberberg and Tsao.

41946 Superallowed Fermi decay of ^{62}Ga. Davids, C.N.; Gagliardi, C.A.; Murphy, M.J.; Norman, E.B. (Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., C;* **19**: No. 4, 1463-1466(Apr 1979).

The superallowed β^+ decay of ^{62}Ga has been studied, using plastic and semiconductor ΔE-E telescopes. The reaction ^{58}Ni(^{6}Li,2n)^{62}Ga was used to produce ^{62}Ga, with E_6Li = 25 MeV. A half-life of 116.34 +- 0.35 ms was obtained, and the total decay energy Q/sub EC/ was measured to be 9171 +- 26 keV. After applying radiative and charge-dependent corrections, the "corrected" ft value Ft = 3081 +- 47 s was obtained, in excellent agreement with the value from Fermi decays in A < or = 54 nuclei.

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 41935

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 41935, 41943

41947 (ORO—1667-17, pp 73-74) **Direct—semidirect reaction contributions in the GDR region of the isobaric analogue states of the reaction ^{88}Sr(p,γ_0).** Potokar, M. 1978.

In Triangle Universities Nuclear Laboratory annual report: TUNL XVII, 1 January—31 December 1978.

The calculated 90° yield and a/sub k/ and b/sub k/ coefficients are compared with previous data and discussed. 1 figure. (RWR)

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, EXPERIMENTAL

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 41946

ENERGY LEVELS AND TRANSITIONS

41948 /sup 72,74,76/Ge by the (t,p) reaction. Lebrun, C.; Guilbault, F.; Ardouin, D.; Flynn, E.R.; Hanson, D.L.; Orbesen, S.D.; Rotbard, R.; Vergnes, M.N. (Institut de Physique, 2 rue Houssiniere, 44072 Nantes, France). *Phys. Rev., C;* **19**: No. 4, 1224-1235(Apr 1979).

A systematic study of all of the stable even germanium isotopes by the (t,p) reaction has been performed. The reaction protons were analyzed in a quadrupole-dipole-dipole-dipole spectrometer with a resulting energy resolution approximately 15 keV. Levels up to 3 MeV in excitation energy were measured and the angular distributions compared to distorted wave analysis. A number of new spin assignments are made in the heavier germanium nuclei. Examination of the systematic trend of the ground state as well as various excited levels strongly supports a transition in nuclear deformation between N = 40 and N = 42. The data also indicate the effects of the approaching shell closure at N = 50.

41949 ^{71}Ga and ^{73}Ga levels as observed in the (t,p) reaction. Vergnes, M.N.; Rotbard, G.; Flynn, E.R.; Hanson, D.L.; Orbesen, S.D.; Guilbaut, F.; Ardouin, D.; Lebrun, C. (Institut de Physique Nucleaire, BP n/sup o/ 1, 91406 Orsay, France). *Phys. Rev., C;* **19**: No. 4, 1276-1287(Apr 1979).

A study of the (t,p) reaction on the two stable Ga isotopes has been performed. The reaction protons were analyzed in a quadrupole-dipole-dipole-dipole spectrometer with a resulting energy resolution approximately 18 keV. Levels up to about 3 MeV excitation energy in ^{71}Ga and 2.75 MeV in ^{73}Ga were measured with 11 new levels observed in the first case and 18 in the second. The angular distributions have been compared to pure distributions observed in the /sup 72.74/Ge(t,p) reactions at the same energy and found to correspond mostly to pure angular momentum (L) transfer although mixing of L's is allowed. A number of new spins assignments are made for Ga levels and the results are used to discuss the spin of ^{73}Zn/sub g.s./. The striking splitting of the L = 0 strength in three approximately equal components, observed in ^{73}Ga, strongly supports a transition in nuclear deformation between N = 40 and 42.

41950 Band structure in ^{78}Rb. Mariscotti, M.A.J.; Garcia Bermudez, G.; Acquadro, J.C.; Lepine, A.; Rao, M.N.; Seale, W.; der Mateosian, E.; Thieberger, P. (Departamento de Fisica, Comision Nacional de Energia Atomica, Buenos Aires 1429, Argentina). *Phys. Rev., C;* **19**: No. 4, 1301-1308(Apr 1979).

A level scheme is proposed for ^{78}Rb, which was obtained through the ^{64}Zn(^{16}O,np) reaction at 44 and 52 MeV, by measuring γ-γ coincidences and γ-ray angular distributions. The isotopic identification was made by studying on- and off-beam spectra at selected time intervals, and determining the intensities of the different decay products. The main part of the level scheme comprises a ΔI = 1 band which shows a staggering similar to that previously found in ^{76}Br and ^{77}Kr. In addition the level energies are very close to those in ^{76}Br. It was not possible to establish in a conclusive manner whether the lowest state of the proposed level scheme corresponds to one or the other of the hitherto known 6 and 17.5 min isomers in ^{78}Rb, but the first possibility appears to be the more likely one.

41951 In-beam gamma-ray spectroscopy of ^{74}Se following the ^{60}Ni(^{16}O,2p), ^{64}Ni(^{12}C,2n) and ^{65}Cu(^{11}B,2n) reactions. Piercey, R.B.; Ramayya, A.V.; Ronningen, R.M.; Hamilton, J.H.; Maruhn-Rezwani, V.; Robinson, R.L.; Kim, H.J. (Department of Physics, Vanderbilt University, Nashville, Tennessee 37235). *Phys. Rev., C;* **19**: No. 4, 1344-1355(Apr 1979).

The energy levels in ^{74}Se produced in the ^{60}Ni(^{16}O,2p), ^{64}Ni(^{12}C,2n) and ^{65}Cu(^{11}B,2n) reactions were studied. An energy level scheme was deduced from γ-γ coincidence measurements. Spin and parity assignments based on angular distribution and directional correlation of oriented nuclei measurements were made for most of the levels. Lifetimes of many of the transitions in ^{74}Se were deduced from their Doppler broadened lineshapes via the Doppler shift attenuation method. Three "rotational-like" band structures to high spin were observed and their properties investigated. A positive parity, ΔJ = 1, band to (9$^+$) as well as the positive parity, ΔJ = 2, yrast band to (14$^+$) were observed. In addition a negative parity, ΔJ = 2, band with rotational-like character was seen to (13$^-$).

MOMENTS AND SPIN

41952 Randomly oriented angular momentum in strongly damped collisions. Dayras, R.A.; Stokstad, R.G.; Fulmer, C.B.; Hensley, D.C.; Halbert, M.L.; Robinson, R.L.; Snell, A.H.; Sarantites, D.G.; Westerberg, L.; Barker, J.H. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev. Lett.;* **42**: No. 11, 697-700(12 Mar 1979).

The first three moments of the γ-ray multiplicity distribution and the out-of-plane γ-ray anisotropy have been measured simultaneously as a function of mass asymmetry for the strongly damped products of the reaction ^{63}Cu with 168-MeV ^{20}Ne. The large variance of the multiplicity appears to be associated with the small anisotropy. These results indicate a random component of angular momentum which is comparable to the aligned component induced by tangential friction.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 41940

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 41935

41953 Nuclear data sheets for A=119. Auble, R.L. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830, USA). *Nucl. Data Sheets;* **26**: No. 2, 207-279(Feb 1979).

Nuclear structure data available through October 1978 are compiled and evaluated. Adopted level and decay properties are given. The bulk of the data is presented pictorially for easy comparison. Experimental details, references, and additional comments, where required, are given in the text. All drawings, tables, and comments are reproduced from the Evaluated Nuclear Structure Data File (ENSDF). Any additions or corrections desired by the users should be addressed to the evaluators for maintenance and updating of the data file.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 41935

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

MASS, ABUNDANCE, AND BINDING ENERGY

41954 Final and primary yields and dispersions for strongly damped reaction of $^{86}Kr + ^{124}Sn$. Blann, M.; Stokes, R.H.; Erkkila, B.; Britt, H.C.; Goldstone, P.D.; Ferguson, R.L.; Plasil, F.; Gutbrod, H.H. (Nuclear Structure Research Laboratory, University of Rochester, Rochester, New York). *Phys. Rev., C;* **19**: No. 4, 1288-1294(Apr 1979).

Fragment mass numbers, charges, and kinetic energies were measured by time of flight and ΔE techniques for reactions of ^{124}Sn targets with ^{86}Kr projectiles at laboratory bombarding energies of 440 and 720 MeV. Dispersions in kinetic energy and mass for fixed atomic number fragments are reported for strongly damped fragments; estimates of the primary dispersions in fragment excitation, kinetic energy, and mass are presented by using the statistical model to estimate broadening due to particle emission. The standard deviation in Q value is found to be nearly a constant 13% of the Q value at both bombarding energies. The experimental yield distributions are shown to be consistent with a division of excitation which is proportional to mass.

NUCLEAR REACTIONS AND SCATTERING

41955 Giant multipole resonances in ^{124}Sn. Nemashkalo, A.A.; Afanas'ev, N.G.; Vladimirov, Y.V.; Likhachev, V.P.; Savitskii, G.A.; Khvastunov, V.M. (Khar'kov Physico-technical Institute, Ukrainian Academy of Sciences). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 1-4(Jul 1978).

Form factors of E1—E7 transitions in ^{124}Sn have been measured at initial electron energies 150 and 225 MeV. Positions and half-widths of the giant dipole, quadrupole, monopole, and octupole resonances have been determined. The reduced transition probabilities and the exhaustion of the corresponding energy-weighted sum rule have been determined for all excitations.

41956 Measurement of the yield of doubly charged particles in capture of K^- mesons by emulsion nuclei. Vaisenberg, A.O.; Pozharova, E.A.; Smirnitskii, V.A. (Institute of Theoretical and Experimental Physics, State Commission on Use of Atomic Energy). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 12-14(Jul 1978).

The interaction of K^- mesons with emulsion nuclei has been studied in order to measure the yield and spectrum of doubly charged particles in σ/sub K/- stars. Separation of singly and doubly charged particles was carried out by counting the number of δ electrons and measurement of multiple scattering, and also by measuring the width of the track. For ranges greater than 500 μm the yield of doubly charged particles is close to 2% and their spectrum falls off with energy, extending up to 80—90 MeV. Under these conditions ~0.023 doubly charged particles are emitted per star. Among particles with range up to 150 μm the yield of doubly charged particles amounts to about 20% and ~0.30 doubly charged particles are emitted per star.

SPONTANEOUS AND INDUCED FISSION

41957 (LA—7739-C) Summary of fission spectrum workshop held at the National Neutron Cross Section Center, Brookhaven National Laboratory, October 23, 1978. Stewart, L. (Los Alamos Scientific Lab., NM (USA)). Mar 1979. Contract W-7405-ENG-36. 13p. (CONF-7810169—(Summ.); ENDF—278). Dep. NTIS, PC A02/MF A01.

From Summary of fission spectrum workshop; Upton, NY, USA (23 Oct 1978).

In response to an action by the Standards Subcommittee of the Cross Section Evaluation Working Group, a workshop was convened to determine the status of available information on prompt fission neutron spectra. The experimental data were reviewed and theoretical models were developed. The current ENDF/B fission neutron spectra files were summarized. Further work is currently under way, especially to provide a better theoretical tool to represent energy-dependent fission spectra. 5 references.

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 41935

41958 Nuclear data sheets for A=154. Harmatz, B. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830, USA). *Nucl. Data Sheets;* **26**: No. 2, 281-384(Feb 1979).

Nuclear structure information available to August 1978 has been reviewed. The level properties obtained from various reaction and decay experiments are shown in the drawings. For odd-odd nuclei, ground and isomeric states are described by p-n coupled Nilsson orbitals. Experimental methods, references, and comments are given in the text.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 41935

41959 Possibility of observing giant resonances of high multipolarity in inelastic scattering of fast protons. Akulinichev, S.V.; Shilov, V.M. (Joint Institute for Nuclear Research). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 25-28(Jul 1978).

With the deformed ^{154}Sm nucleus as an example, we demonstrate the possibility of observing different isoscalar giant resonances in inelastic scattering of protons of energy 1 GeV. To calculate the differential and integral scattering cross sections we use the microscopic transition densities in the Glauber model.

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

41960 $^{181}Ta(p,2n\gamma)^{180}W$ reaction. Mann, L.G.; Carlson, J.B.; Lanier, R.G.; Struble, G.L.; Buckley, W.M.; Heikkinen, D.W.; Proctor, I.D.; Sheline, R.K. (Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev., C;* **19**: No. 4, 1191-1204(Apr 1979).

States populated by the $^{181}Ta(p,2n\gamma)^{180}W$ reaction were studied using in-beam γ-ray spectroscopy with standard techniques that included fast timing, coincidences, and angular distributions. We populate the previously well characterized bands built on the ground state and the 5.2-ms 8^- state at 1529.0 keV up to the 12^+ and 12^- levels, respectively. In addition we identify the rotational band built on the 7.4-ns $K = 2^-$ octupole vibrational state at 1006.4 keV up to the J/sup π/ = 11^- member and we observe the decoupling of the octupole phonon from the core rotation. A state at 1634.6 keV is populated with moderate intensity. If this state is the one reported at 1637 keV in (d,d/sup prime/) excitation then it is most likely the $K = 3^-$ octupole vibration. We observe the gamma-vibrational band up to the spin 7 member and also a new band built on a metastable state at 1639.8 keV. This state has a half life of 19.2 +- 0.3 ns and most likely J = 5 with uncertain parity.

41961 Giant resonance in transitional nuclei: Photoneutron cross sections for osmium isotopes. Berman, B.L.; Faul, D.D.; Alvarez, R.A.; Meyer, P.; Olson, D.L. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Rev., C;* **19**: No. 4, 1205-1223(Apr 1979).

Photoneutron cross sections, including σ[(γ,n) + (γ,pn)], σ[(γ,2n) + (γ,p2n)], and σ (γ,3n), were measured for ^{188}Os, ^{189}Os, ^{190}Os, and ^{192}Os from 7 to 30 MeV and for ^{186}Os from 11 to 20 MeV, with a photon energy resolution of about 300 keV. The source of radiation was the monoenergetic photon beam obtained from the annihilation in flight of fast positrons. The partial photoneutron cross sections were determined by neutron multiplicity counting, and the average neutron energies for each multiplicity were determined simultaneously with the cross-section data by the ring-ratio technique. Nuclear information extracted from the data includes parameters of the giant dipole and giant quadrupole resonances, integrated cross sections and their moments, nuclear symmetry energies, and nuclear deformation parameters and intrinsic quadrupole moments. No fewer than eight kinds of evidence point to a sudden change of behavior between ^{189}Os and ^{190}Os, which could be interpreted as a phase transition from a statically deformed prolate nucleus to a γ-unstable one, in general (but not detailed) agreement with the prediction of a dynamic-collective-model calculation.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 41961

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, THEORETICAL

MASS, ABUNDANCE, AND BINDING ENERGY

41962 Shell corrections to the semiempirical formulae for nuclear masses and mean square radii. Bunatyan, G.G. (Joint Institute for Nuclear Research). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 35-39(Jul 1978).

The corrections to the semiempirical (liquid drop) values of the binding energy δE and the mean square radius $\delta\langle r^2\rangle$ are calculated for heavy spherical nuclei. The corrections are caused by the nuclear shell structure. The strong nucleon interaction is included consistently in the calculation. The accuracy of the calculations, based on the shell-correction method, is studied in detail. The dependence of the results on the parameters employed is investigated. The resulting δE and $\delta\langle r^2\rangle$ values are compared with the experimental data. The calculations are performed for nuclei in vicinity of ^{208}Pb and for nuclei with 110< or =Z< or =120 and 174< or =N< or =188 (super-heavy nuclei). Based on our analysis, one does not expect a doubly magic nucleus, similar to ^{208}Pb, at such large values of Z and N. For these nuclei the shell correction is almost constant, δE=-8—10 MeV, when they are treated as spherical nuclei. This result, perhaps, suggests an enhanced stability of a large number of such nuclei. The half lives for α-decay of such nuclei are estimated.

ENERGY LEVELS AND TRANSITIONS

41963 Rotation-vibration structure of ^{196}Pt; an alternative to the O(6) -limit description. Hsu, H.H.; Wohn, F.K.; Williams, S.A. (Department of Physics, University of Northern Iowa, Cedar Falls, Iowa 50613). *Phys. Rev., C;* **19**: No. 4, 1550-1552(Apr 1979).

Comparison is made between the predictions of the rotation-vibration description of ^{196}Pt and that afforded by the O(6) limit of the interacting boson approximation.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

REFER ALSO TO CITATION(S) 41961

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 41964

SPONTANEOUS AND INDUCED FISSION

41964 (CONF-790507—2) **Neutron induced ^{238}U subthreshold fission cross section for neutron energies between 5 eV and 3.5 MeV.** Perez, R.B.; Difilippo, F.C.; de Saussure, G.; Ingle, R.W. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 6p. Dep. NTIS, PC A02/MF A01.

From IAEA symposium on physics and chemistry of fission; Julich, F.R. Germany (14 May 1979).

A measurement of the ^{238}U fission cross section between 5 eV and 3.5 MeV was performed. Included is the identification of 85 resonances or clusters of resonances below 200 keV. Also the fission widths for the 27 resolved class I levels were computed from their fission areas, and a neutron width of 0.005 MeV was estimated for the quasi-class II level in the 721 eV fission cluster. The fission level spacing and cross sections are discussed. 9 references. (JFP)

NUCLEAR THEORY

NUCLEAR STRUCTURE

41965 Perturbation of linearly transformed energy spectra by configuration mixing. Moszkowski, S.A.; Hausman, R.F.; Bloom, S.D. (Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev., C;* **19**: No. 4, 1523-1529(Apr 1979).

We study the effect of configuration mixing on the well known linear relations between the energy spectra of j^2 and j/sup n/ configurations. We show that both single-particle excitations and third-order corrections lead to breakdown of these relations. Contributions from the former tend to cancel when many high-lying orbits contribute simultaneously.

41966 One-boson exchange potentials and spin-orbit splitting of single-particle levels in nuclei. Savushkin, L.N.; Fomenko, V.N. (Leningrad Electrotechnical Institute of Communications). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 29-32(Jul 1978).

The contribution of all the components of one-boson exchange potentials to the spin-orbit splittings of single-particle states of nuclei are determined. Spherical and deformed nuclei are considered, and the one-boson exchange potential is taken into account in an approximation quadratic in the relative momentum. It is shown that all the components of the potential play an essential role for spin-unsaturated nuclei.

NUCLEAR REACTIONS AND SCATTERING

41967 (UCRL—50400(Vol.18)) **ACTL: evaluated neutron activation cross section library-evaluation techniques and reaction index.** Gardner, M.A.; Howerton, R.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 17 Oct 1978. Contract W-7405-ENG-48. 102p. Dep. NTIS, PC A06/MF A01.

A library of evaluated neutron-induced activation cross sections (ACTL) was compiled. The library covers incident neutron energies from 10^{-10} to 20 MeV. General descriptions of the evaluation methods and an index to the evaluated cross sections are presented. 21 references.

41968 Eikonal approximation and distortions in the mechanism of heavy-particle stripping. Zelenskaya, N.S.; Lebedev, V.M.; Yushchenko, T.A. (Institute for Nuclear Physics, Moscow State University). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 44-47(Jul 1978).

It is shown that the introduction of plane-wave distortions for the heavy-particle stripping mechanism in the eikonal approximation enables one to describe the angular distribution of d, ^{3}He, and α-particle elastic scattering, as well as that of reactions between α particles and light nuclei in the range of large angles, in satisfactory agreement with experiment. It is noted that the basic qualitative features of the angular distributions at large angles are determined not by the distortions, but by the scattering or reaction mechanism itself.

RADIOACTIVE DECAY

41969 E2 fluctuation radiation of heated spherical nuclei. Budnick, A.P.; Svin'in, I.R. (Physics and Power Engineering Institute, Obninsk). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 21-24(Jul 1978).

We consider a quantum-mechanical model of E2 fluctuation radiation from heated spherical nuclei which, in contrast with the classical model [D. P. Grechukhin, Yad. Fiz. 4, 1134 (1966)], is also applicable in the range of nuclear temperatures comparable with the characteristic energy of quadrupole oscillations.

SPONTANEOUS AND INDUCED FISSION

41970 (IAEA-SM—241-D1) **Heavy-ion-induced fission following fusion.** Plasil, F.; Ferguson, R.L. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 38p. (CONF-790507—3). Dep. NTIS, PC A03/MF A01.

From IAEA symposium on physics and chemistry of fission; Julich, F.R. Germany (14 May 1979).

Theoretical considerations of fission of systems with high angular momenta are usually made in the framework of the rotating liquid drop model. The most stringent tests of this theory involve studies of excitation functions for evaporation residue products. At present there is no evidence for the survival of any rotating system which is predicted not to have a fission barrier. The extent to which the vanishing fission barrier imposes a limit on evaporation residue cross sections will be discussed in this review with reference to several cases, ranging from very light systems, such as ^{14}N + ^{12}C to medium mass systems, such as ^{86}Kr + ^{65}Cu. The prevalence of deeply inelastic processes in heavy ion reactions poses a problem for arriving at an operational definition of heavy-ion-induced fission. This in turn makes it difficult to define fusion of complex nuclei. While some yield at symmetric mass divisions is usually observed and while the products in this region often have fission-like kinetic energies and even angular distributions, indications are that in most cases tails of strongly damped distributions are involved, rather than the fusion—fusion process. In some cases, there is strong evidence for the existence of a separate and distinct fission component. When excitation functions for both evaporation residue products and for well-characterized fission fragments are available, it is possible to carry out a statistical model analysis and extract values of the fission barrier. Beckerman and Blann have carried out such analyses and concluded that liquid drop fission barriers must be reduced by approximately 40% to reproduce experimental results. A critical appraisal of this conclusion is given. New results are introduced on data allowing a very stringent test of the theory of angular-momentum dependence of fission barriers. 40 references.

RADIATION AND SHIELDING PHYSICS

NEUTRON INTERACTIONS WITH MATTER

41971 (IAEA—207, pp 531-542) **100-group, 2-D calculation of the Winfrith iron benchmark experiment.** Burn, K.; Canali, U.; Nicks, R. (Commission of the European Communities, Ispra (Italy). Joint Research Centre). 1978.

From Specialists meeting on nuclear data requirements for shielding; Vienna, Austria (8 Oct 1976).

The neutron flux measured in the integral iron benchmark experiment at the ASPIS facility (Winfrith) has been calculated by means of the 2-Dimensional DOT Code, using the 100-group EURLIB standard library (based on ENDFB/III). The calculation has been done in a P3/S4 approximation. The results are compared with the experimental ones concerning the neutron spectra at four penetrations into the iron block. For large depths the calculation appreciably underestimates the fast component above 0.8 MeV, indicating possibly an inadequacy of the fast neutron cross-sections for iron in EURLIB. The results of these 100-group calculations are reduced to the agreed 15 group structure and are compared with those using a 15-group library obtained by collapsing EURLIB. Both calculations severely underestimate the flux above 0.1 MeV, at depths greater than 50cm; the finer group structure does not significantly reduce this discrepancy. The 100 group calculation has been repeated with the EURLIB-3 library, based on ENDF/B-IV, and the differences are discussed.

41972 (IAEA—207, pp 563-572) **Evaluation of the effect of errors in group constants on calculations of neutron fields in shielding.** Germogenova, T.A.; Suvorov, A.P.; Utkin, V.A. 1978.

From Specialists meeting on nuclear data requirements for shielding; Vienna, Austria (8 Oct 1976).

Analytical expressions for the asymptotic neutron flux sensitivity function in an infinite homogeneous medium (plate geometry, isotopic scattering) to the neutron cross-section uncertainties were derived for the one-dimensional problem of neutron propagation in a shield. The results were compared with calculations performed by the discrete ordinate code ROZ-5. Investigation of the sensitivity function for Fe-H_2O two-layer shields was made for the multigroup problem. Accuracy of neutron flux calculation results behind the shield was estimated.

41973 United States national small-angle neutron scattering facility. Koehler, W.C.; Hendricks, R.W. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Appl. Phys.;* **50**: No. B3, 1951(1 Mar 1979).

A status report is presented for the new U. S. national, user-oriented, small-angle neutron scattering facility under construction at Oak Ridge National Laboratory.

41974 Uses of pulsed neutron sources for research in magnetism and other areas of condensed matter physics. Sinha, S.K. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Appl. Phys.;* **50**: No. B3, 1952-1957(1 Mar 1979).

The next decade will see the development worldwide of pulsed spallation neutron sources for condensed matter research. A conceptual introduction to such neutron sources is given. Neutron time-of-flight techniques as applied to diffraction and inelastic neutron scattering spectroscopy are discussed, and compared with techniques using crystal spectrometers. The advantages of such sources such as high effective thermal and higher energy neutron fluxes for certain kinds of experiments are discussed. The applications of these sources to various areas of condensed matter research are reviewed, with special emphasis on the study of magnetism. Finally, a brief account is given of the status of pulsed spallation source development around the world.

41975 Spurious effects in the study of the triple correlation in the decay of polarized neutrons and new results in the search for time reversal invariance violation. Erozolimskii, B.G.; Mostovoi, Y.A.; Fedunin, V.P.; Frank, A.I.; Khakhan, O.V. (I. V. Kurchatov Atomic Energy Institute). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 48-51(Jul 1978).

It is shown that the apparatus symmetry used in previous triple-correlation measurements to eliminate systematic errors due to contributions from known correlations does not guarantee an accuracy of $\sim 10^{-3}$. Spurious effects can arise as a result of loss of protons or from variations in the direction of the polarization vector within the beam cross section. Measurements in which the experimental conditions were periodically altered made it possible to reveal this error and to eliminate it from the final result. The value $D = +0.0022 +- 0.0030$ was obtained for the triple-correlation coefficient; this corresponds to an angle $\theta = 179.71 +- 0.39°$ between the vector and axial vector weak interaction constants.

41976 Electric and magnetic dipole moments of the neutron. Ramsey, N.F. (Harvard Univ., Cambridge, MA). pp 453-471 of Atomic Physics 5. Marrus, R.; Prior, M.; Shugart, H. (eds.). New York, NY; Plenum Press (1977).

From 5. international conference on atomic physics; Berkeley, CA, USA (26 Jul 1976).

Experiments to measure the electric and magnetic dipole moments of the neutron are described. The apparatus used in this experiment is one to measure with high precision the precessional frequency of the neutron spin in a weak magnetic field with a neutron beam magnetic resonance apparatus similar to that used for measuring the magnetic moment of the neutron. Results of the measurement are presented. 52 references. (GHT)

MEDICAL PHYSICS

DOSIMETRY

41977 Variation in output factor caused by secondary blocking for 7—16 MeV electron beams. Choi, M.C.; Purdy, J.A.; Gerbi, B.; Abrath, F.G.; Glasgow, G.P. (Physics Section, Division of Radiation Oncology, Mallinckrodt Institute of Radiology, Washington University School of Medicine, St. Louis, Missouri 63110). *Med. Phys.;* **6**: No. 2, 137-139(Mar 1979).

The effect of secondary blocking on the output factor for 7—16 MeV electron beams is investigated for the two most widely used methods of field shaping, i.e.,(a) shield on surface, and (b) shield at end of cone with subsequent air gap. For these two methods differences in output on the order of 10% are observed. These effects are explained in terms of the blocking geometry and its influence on scattered radiation.

SOLID STATE PHYSICS

REFER ALSO TO CITATION(S) 41195, 41309, 41843

41978 Microscopic aspects of metal-GaAs interface formation. Bachrach, R.Z. (Xerox Palo Alto Research Center, Palo Alto, CA); Bauer, R.S.; McMenamin, J.C.; Bianconi, A. pp 1073-1076 of Physics of semiconductors, 1978. Wilson, B.L.H. (ed.). Bristol, England; The Institute of Physics (1979).

From 14. conference on the physics of semiconductors; Edinburgh, UK (4 Sep 1978).

The interfacial chemistry and electronic structure of aluminum and gallium deposited at room temperature onto (110) GaAs from an MBE type thermal source have been investigated. The results show that the electronic properties of the interfaces are dominated by chemical reactions and bond formation. The individual metal and semiconductor surface properties have been characterized, but these are modified at the interface.

41979 Small-polaronic diffusion of light interstitials in bcc metals. Emin, D.; Baskes, M.I.; Wilson, W.D. (Sandia Laboratories, Albuquerque, New Mexico 87185). *Phys. Rev. Lett.;* **42**: No. 12, 791-794(19 Mar 1979).

The small-polaronic diffusion associated with simple models of light interstitials in bcc metals has been investigated. By transcending the simplifications which are often introduced in studying electronic small-polaron transport, we calculate diffusion coefficients which are reasonably consistent with available data. In particular, an explanation of the "anamalous" isotope dependence observed for hydrogen diffusion in bcc metals emerges from these studies.

41980 Role of electron-electron interactions in the RKKY theory of magnetism. Cooke, J.F. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Appl. Phys.;* **50**: No. B3, 1782-1784(1 Mar 1979).

The theory of magnetism in heavy rare earth metals is based on the RKKY theory. In this formalism the indirect exchange interaction between the local 4f spins is mediated by the conduction electrons. When carried to second order in the 4f-conduction electron interaction, traditional pertubation theory leads to a Heisenberg-like interaction between the local spins which depends on the electronic energy bands and 4f-conduction electron exchange matrix elements. This derivation neglects the detailed behavior of electron-electron interaction within the conduction band, which is known to be important in metallic systems. By using an equation of motion method, an expression for the inelastic neutron scattering cross-section has been derived which includes, in an approximate way, this electron-electron interaction. The results of this calculation indicate that spin-wave peaks can be broadened and shifted if the spin-wave band lies near the conduction electron Stoner continuum. The origin of this effect is similar to that found in itinerant electron systems where the spin-wave band actually intersects the Stoner continuum, resulting in the disappearance of the spin-wave mode.

41981 Renormalization group and other calculations for the one-dimensional spin-1/2 dimerized Heisenberg antiferromagnet. Fields, J.N.; Bloete, H.W.J.; Bonner, J.C. (Brookhaven National Lab., Upton, L.I., New York 11973). *J. Appl. Phys.;* **50**: No. B3, 1807-1809(1 Mar 1979).

A zero-temperature renormalization group (RG) approach is applied to the one-dimensional, spin-1/2 antiferromagnetic Heisenberg dimerized (alternating) chain. Specifically, the ground state energy and lowest-lying spectral excitations are examined. The cal-

culation indicates the existence of a gap in the spectrum of the dimerized chain which vanishes only in the limit of a uniform spin chain, in contrast to a recent Green's function approach. The RG results are in reasonable agreement with numerical extrapolations on the exact eigenvalue spectrum of finite chains of up to 12 spins. Both methods are compared with several other approximate treatments of the Heisenberg system, and tested by comparison with exact results for the spin-1/2 XY dimerized chain.

41982 Effect of electron—phonon interactions on retarded cyclotron resonance. Makarov, N.M.; Sodin, S.L. (Institute of Radio Physics and Electronics, Academy of Sciences of the Ukrainian SSR). *Sov. J. Low Temp. Phys. (Engl. Transl.);* 4: No. 8, 464-468(Aug 1978).

Effects of electron—phonon interactions on cyclotron resonance line shapes are investigated under conditions of strong retardation effects. The resonance line shape is found in the case of "sharp" resonance. Anomalous and normal skin effects are considered. Equations are obtained for the resonance frequency shift and for the effective electron relaxation frequency with external electromagnetic wave frequencies much higher and much lower than the Debye frequency. It is shown that for frequencies low in comparison with the Debye frequency the resonance frequency shift exceeds the effective electron relaxation frequency.

41983 Dislocation theory of isotropic polycrystallie plasticity. Werne, R.W.; Kelly, J.M. (Univ. of California, Livermore). W-74-05-ENG-48. *Int. J. Eng. Sci.;* 16: No. 12, 951-965(1978).

A theory of polycrystalline plasticity is developed in which the polycrystalline solid is modeled as an isotropic continuum. The rate of plastic deformation tensor is shown to be a function of the mobile dislocation density and the dislocation velocity vector summed over all active glide planes. The dislocation velocity vector is expessed in terms of the stress tensor and the normal vector to the dislocation glide plane. The condition of plastic incompressibility yields the fact that the dislocation glide planes are the octahedral shear planes of the stress tensor. As a special case the rate of plastic deformation tensor reduces to a relation analogous to the Prandtl—Reuss flow rule. The theory has been implemented in a 2-dimensional finite element code and two example problems are presented.

SOLID STATE PLASMA

41984 (AD-A—060310) Optically induced hot electron effects in semiconductors. Summary report, 1 September 1976—31 August 1978. Smirl, A.L. (North Texas State Univ., Denton (USA). Dept. of Physics). 31 Aug 1978. Contract N00014-76-C-1077. 103p. NTIS PC A06/MF A01.

Progress is reported in using the high electric fields and ultrashort pulses from mode-locked lasers to study the temporal evolution of the saturable optical properties of semiconductors on a picosecond time scale. In these studies, the excite and probe technique is employed to obtain information concerning the ultrafast dynamics of photogenerated electron-hole plasmas. Germanium has been chosen for the initial investigations since its bandgap energy is comparable to, but less than, the photon energy of the Nd: glass laser.

SUPERCONDUCTIVITY

REFER ALSO TO CITATION(S) 41206

GENERAL THEORY

41985 Superconductivity of metals taking account of the repulsion of ion cores. Gabovich, A.M.; Moiseev, D.P. (Institute of Physics, Academy of Sciences of the Ukrainian SSR). *Sov. J. Low Temp. Phys. (Engl. Transl.);* 4: No. 9, 525-529(Sep 1978).

Within the framework of the Brout model, which is an extension of the "jellium" model and takes account of the Born—Mayer repulsion of ion cores in metals with filled or almost filled d-shells, a dependence of the critical temperature of the superconducting transition T/sub c/ on the system parameters is found. It is shown that T/sub c/ diminishes with the increase in the dimensionless parameter θ characterizing the magnitude of the Born—Mayer force. A superconductivity criterion is obtained in the Brout model and domains of normal and superconducting phases in the plane of the parameter θ and the quantity α dependent on the concentration of conduction electrons are found.

ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA

REFER ALSO TO CITATION(S) 41261, 41337, 41354, 41852

41986 (BNL—25940) Effects of stoichiometry and neutron irradiation in superconducting A-15 compounds. Moehlecke, S. (Universidade Estadual de Campinas (Brazil); Brookhaven National Lab., Upton, NY (USA)). 1978. Contract EY-76-C-02-0016. 232p. Dep. NTIS, PC A11/MF A01.

Thesis.

The A-15 (A_3B) compounds comprise an important class of superconducting compounds. In order to gain a clearer understanding of the parameters influencing the superconductivity in these materials, several A-15 compounds have been prepared and the effects of varying stoichiometry, heat treatment, and irradiation with high energy neutrons (E > 1 MeV) on the superconducting transition temperature T/sub c/, Bragg—William order parameter S, and the lattice parameter a_o, have been studied. The systems investigated include Nb_3Ge, Nb_3Al, Nb_3Pt, Nb_3Ir, V_3Ga, V_3Si and Mo_3Os. Some of the results may be summarized as follows: 1) for Nb_3Al, Nb_3Pt and V_3Ga, T/sub c/ is a strong function of composition, reaching a maximum value at the ideal stoichiometric composition of 3A: 1B, if that composition exists in the equilibrium phase diagram, 2) irradiation with high energy neutrons at temperatures of ~150°C results in drastic lowering of T/sub c/ for Nb_3Al, Nb_3Pt and Nb_3Ge, but not for Mo_3Os, 3) T/sub c/ can be recovered by annealing, the recovery temperature being in the range 300-800°C depends on the particular compound, 4) the order parameter S, decreases with increasing neutron fluence (decreasing T/sub c/), and is also recoverable upon annealing at the appropriate temperature, 5) the lattice parameter a_o, increases with increasing neutron fluence, and isalso restored to its original value by annealing. A simple hard sphere model is developed to calculate the dependence of a_o on composition within the A-15 phase. Excellent agreement is obtained for the measured values in the Nb—Al, Nb—Pt and V—Ga systems. The results of both compositionally and irradiation induced disorder can be understood on the basis of site-exchange taking placee between the A and B sites in the A-15 structure.

41987 (CALT—822-108) Magnetic impurities in amorphous superconductors: T/sub KONDO/ > T/sub c/. Domb, E.R.; MacDonald, C.A.; Johnson, W.L. (California Inst. of Tech., Pasadena (USA). W.M. Keck Lab. of Engineering Materials). Feb 1979. Contract EY-76-C-03-0822. 16p. Dep. NTIS, PC A02/MF A01.

Measurements of upper critical field as a function of temperature and Fe-concentration are reported for the amorphous superconductors $((Mo_{.8}Ru_{.4})_{80}G_{20})$/sub l-c/Fe/sub c/, where G is a glass-former. The linear shapes of the H/sub c2/ vs T curves near T/sub c/ agree well with predictions made by Matsura, Ichinose, and Nagaoka, for T/sub Kondo/ much greater than T/sub c/.

41988 (COO—2890-3) Flux pinning and flux flow studies in superconductors using flux flow noise techniques. Progress report, April 1, 1978—December 30, 1978. Joiner, W.C.H. (Cincinnati Univ., OH (USA). Dept. of Physics). Dec 1978. Contract EY-76-S-02-2890. 79p. Dep. NTIS, PC A05/MF A01.

During the past year the experimental procedure by which flux flow noise data are obtained was changed. Instead of making point by point measurements using a wave analyzer, sequential voltage measurements are recorded, and a Fast Fourier Transform is used. Whereas previously a noise spectrum constituted approximately 20 experimental points, a spectrum is now formed from 2048 points, and 90 specta are averaged point by point to form our final averaged spectrum. This procedure provides much greater accuracy and reproducibility, and permits a much improved rate of data acquisition. The theoretical model for flux motion interrupted by pinning interactions has been modified slightly in response to other theoretical developments. The expressions for the noise spectra and the I-V characteristics are unaltered, and continue to provide excellent fits to our data. Flux flow noise has been studied in $Pb_{50}In_{50}$ samples immediately after cold work, during recovery, and after annealing. A rather complete study in the latter stage reveals many fundamental aspects of flux flow noise. At each stage changes in the noise characteristics are correlated with changes in the volume pinning force. Studies of a PbSn alloy as a laminar normal metal precipitate evolves, confirm noise predictions, and reveal new hysteretic effects. Values of I/sub o/I/sub c/ derived from I-V characteristics provide valuable additional information about pinning and the initiation of flux flow. A brief review is given of the major results, followed by more detailed accounts in the appendices.

41989 (COO—4938-1) Superconductivity in filamentary eutectic composites. Progress report, June 1, 1978—May 31, 1979. Zaitlin, M.P. (Dartmouth Coll., Hanover, NH (USA). Dept. of Physics and Astronomy). 1979. Contract ER-78-S-02-4938. 8p. Dep. NTIS, PC A02/MF A01.

Progress made under DOE Contract No. ER-78-S-02-4938 has been in two areas. The design, construction, and testing of a helium temperature cryostat along with its associated electronics has been essentially completed, and measurements of the electrical resistivity of Nb—Th filamentary eutectic composites have been initiated.

41990 Theory of longitudinal sound attenuation in superconductors with paramagnetic impurities. Galaiko, V.P.; Glushchuk, N.I. (Physicotechnical Institute of Low Temperatures, Academy of Sciences of the Ukrainian SSR). *Sov. J. Low Temp. Phys. (Engl. Transl.);* **4**: No. 10, 585-590(Oct 1978).

A study is made of the nonequilibrium processes associated with the propagation of a longitudinal sound wave in a superconductor with a low concentration of paramagnetic impurities ($\Delta\tau >> 1$, $\Delta\tau/\tau_s >> 1$). The longitudinal electric fields produced in this case affect the "mixing," specific to superconductors, of the electron and hole branches of the energy spectrum. The magnetic impurities, oscillating with the lattice, on the one hand, produce a kinetic effect, namely, drag of the normal electrons and slippage of the superconducting condensate, and on the other hand, ensure paramagnetic branch mixing. Moreover, in the superconducting state the momentum transfer from electrons to impurities in collisions proves to be nonzero. The longitudinal sound attenuation calculated by taking these effects into account differs from the results of the BCS method.

41991 Low temperature research and superconductivity. Strongin, M. (Brookhaven National Lab., Upton, NY (USA)); Clinton, W.L. (Energy Research and Development Administration, Washington, DC (USA). Div. of Physical Research); Mercereau, J.E. (California Inst. of Tech., Pasadena (USA)); Wheatley, J.C. (California Univ., San Diego, La Jolla (USA)). *Mater. Sci. Eng.;* **35**: No. 1, 57-74(Sep 1978).

The workshop summarized here discussed the related areas of low-temperature physics and superconductivity and their relationship to the energy technologies.

THEORETICAL PHYSICS

GENERAL AND MISCELLANEOUS

41992 Dynamics of a relativistic string. Barbashov, B.M.; Nesterenko, V.V. (Joint Institute for Nuclear Research, Dubna). *Sov. J. Particles Nucl. (Engl. Transl.);* **9**: No. 5, 391-409(Sep 1978).

The classical and quantum dynamics of a relativistic string that is either free or has charges and masses at its end is reviewed. The general solution of the Cauchy problem for the equations of motion of the string, and also a number of particular solutions, are discussed. Besides the standard methods of quantization, an approach is presented that makes it possible to construct a relativistically invariant quantum theory of a string without restrictions on the space-time dimension and without tachyon states. The nonrelativistic limit of a string with masses at the ends is investigated. Stringlike solutions in field models are considered and the relation between a relativistic string and the problem of quark confinement in hadrons is discussed. The connection between the nonlinear Born-Infeld models and a string are examined.

CLASSICAL AND QUANTUM MECHANICS

REFER ALSO TO CITATION(S) 41919

41993 Whiteheadian approach to quantum theory and the generalized bell's theorem. Stapp, H.P. (Lawrence Berkeley Laboratory, University of California, Berkeley, California). *Found. Phys.;* **9**: No. 1, 1-26(Feb 1979).

The model of the world proposed by Whitehead provides a natural theoretical framework in which to imbed quantum theory. This model accords with the ontological ideas of Heisenberg, and also with Einstein's view that physical theories should refer nominally to the objective physical situation, rather than our knowledge of that system. Whitehead imposed on his model the relativistic requirement that what happens in any given spacetime region be determined only by what has happened in its absolute past, i.e., in the backward light-cone drawn from that region. This requirement must be modified, for it is inconsistent with the implications of quantum theory expressed by a generalized version of Bell's theorem. Revamping the causal spacetime structure of the Whitehead-Heisenberg ontology to bring it into accord with the generalized Bell's theorem creates the possibility of a nonlocal causal covariant theory that accords with the statistical prediction of quantum theory.

RELATIVITY AND GRAVITATION

41994 Newman-Penrose formalism and its application in the general theory of relativity. Alekseev, G.A.; Khlebnikov, V.I. (V. A. Steklov Mathematics Institute, USSR Academy of Sciences, Moscow). *Sov. J. Particles Nucl. (Engl. Transl.);* **9**: No. 5, 421-451(Sep 1978).

In this review, we give a systematic exposition of the Newman-Penrose formalism in the general theory of relativity and we use this formalism to describe some general properties of gravitational fields that are intimately related to the behavior of null curves and null surfaces in Riemannian space-time. Actual methods of integrating the complete system of Newman-Penrose equations are considered in detail for gravitational fields of some algebraically special types in the Petrov classification in vacuum and in radiation-filled space-time. A separate section is devoted to applications of the spin coefficient formalism to the description of the propagation of gravitational and electromagnetic waves of small amplitude in a given external gravitational field, in particular, in the field of a black hole.

OPTICS

41995 Raman and fluorescent scattering by molecules embedded in spheres with radii up to several multiples of the wavelength. Kerker, M.; Druger, S.D. (Clarkson College of Technology, Potsdam, New York 13676). *Appl. Opt.;* **18**: No. 8, 1172-1179(15 Apr 1979).

When molecules which give rise to Raman and fluorescent light scattering are distributed within a small dielectric particle, the signal is affected by the morphology and optical properties of the particle and by the distribution of active molecules within it. This effect is considered to arise from the influence of the particle boundary both upon the internal field at the incident frequency and upon the emissions at the shifted frequency rather than from any alteration of the molecular transitions. This study presents numerical results over a broad range of refractive indexes and for larger size parameters than heretofore. It includes explicit consideration of components polarized in the same plane as the incident field, H_h and V_ν, as well as the depolarized components V_h and H_ν. Quantitative estimates of the concentration of active species may be in error if these effects are not considered.

STATISTICAL PHYSICS AND THERMODYNAMICS

41996 Monte Carlo renormalization group. Swendsen, R.H. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev. Lett.;* **42**: No. 14, 859-861(2 Apr 1979).

A simplified method of applying a renormalization-group analysis to Monte Carlo simulations of general systems is presented and illustrated with applications to the Ising model and the three-state Potts model.

ELECTRICITY AND MAGNETISM

41997 (UCRL-Trans—11459) **Numerical modeling of the compression of a magnetic field by a shaping liner.** Volkova, R.A.; Goloviznin, V.M.; Ulinich, A.R.; Favorskii, A.P. Feb 1979. Translation of USSR report, pp 1-66. 69p. Dep. NTIS, PC A04/MF A01.

An investigation is made by methods of numerical modeling of the process of the development of the Taylor instability during compression of the magnetic field by a superconducting liquid-metal liner. The effect of formation of shaped jets and the effect of self-piercing of the liner were observed. A comparison is made with both the results of one-dimensional calculations and the results of some experiments. 25 references.

MATHEMATICAL PHYSICS

REFER ALSO TO CITATION(S) 41785

41998 (DOE/ER/03443—79) **Numerical solution of Helmholtz equation by the finite element method.** Aziz, A.K.; Werschulz, A. (Maryland Univ., College Park (USA). Inst. for Physical Science and Technology). Jan 1979. Contract EY-76-S-05-3443. 14p. Dep. NTIS, PC A02/MF A01.

The numerical solution of the Helmholtz boundary value problem is considered. An optimal error bound in a general context is obtained which contains as a special case an optimal error estimate. The key to this approach lies in reducing the solution of the boundary value problem by a two-stage finite element procedure to the solution of a 2 x 2 first order elliptic system of the Petrovski type for which suitable shift theorems are known. A numerical example is given for a certain case. The computed error estimates agree with the theoretical estimates given. 11 references. (JFP)

41999 (DOE/ER/03443—80) **Uniqueness of Neumann-Tricomi problem in R^2. Technical note BN-906.** Aziz, A.K.; Schneider, M. (Maryland Univ., College Park (USA). Inst. for Physical Science and Technology). Apr 1979. Contract EY-76-S-05-3443. 21p. Dep. NTIS, PC A02/MF A01.

Using a variation of the energy-integral method sufficient conditions for the uniqueness of the solution of the Neumann-Tricomi boundary value problem are obtained. A uniqueness theorem is given for a general function. 11 references. (JFP)

42000 (LA-UR—79-837) **Method of lines approach to the numerical solution of conservation laws.** Hyman, J.M. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 14p. (CONF-790619—1). Dep. NTIS, PC A02/MF A01.

From 3. IMACS international symposium on computer methods for partial differential equation; Bethlehem, PA, USA (20 Jun 1979).

New explicit finite difference methods are developed for approximating the discontinuous time dependent solutions of nonlinear hyperbolic conservation laws. The analysis is based on the method of lines approach of decoupling the space and time discretizations and analyzing each independently before combining them into a composite method. Particular attention is given analyzing to high order spatial differences, artificial dissipation and the accurate approximation of boundary conditions. Both a third order iterated leap-frog predictor-corrector and a second order iterated Runge—Kutta method are shown to have excellent stability and accuracy properties for the time integration. These methods are A-stable when iterated to convergence and have the special property of allowing for local improvements in the stability and accuracy of the computed solution. The paper is designed to aid a scientist or engineer construct a numerical method specially tailored to a specific problem. The analysis requires an elementary knowledge of the numerical solution of ordinary differential equations, finite difference theory and gas dynamics.

42001 (ORO—5126-50) **Time-dependent Hartree—Fock phase: unique implication of variational principle.** Lichtner, P.C.; Griffin, J.J.; Schultheis, H.; Schultheis, R.; Volkov, A.B. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). Mar 1979. Contract EY-76-S-05-5126. 11p. Dep. NTIS, PC A02/MF A01.

The time-dependent Hartree-Fock (TDHF) variational principle is shown to yield a unique solution with no indeterminacy in its time-dependent phase. The long-standing contrary opinion arises from an impermissible restriction to norm-preserving variations. 9 references.

42002 (STAN-CS—78-684) **Matrix inverse eigenvalue problem for periodic Jacobi matrices.** Boley, D.L.; Golub, G.H. (Stanford Univ., CA (USA). Dept. of Computer Science). Dec 1978. Contract EY-76-S-03-0326-030. 17p. (CONF-7809139—1). Dep. NTIS, PC A02/MF A01.

From 4. conference on basic problems of numerical analysis; Pilsen, Czechoslovakia (Sep 1978).

A stable numerical algorithm is presented for generating a periodic Jacobi matrix from two sets of eigenvalues and the product of the off-diagonal elements of the matrix. The algorithm requires a simple generalization of the Lanczos algorithm. It is shown that the matrix is not unique, but the algorithm will generate all possible solutions. 3 references.

42003 **Variational nature of eigenvalue problems with a parameter.** Schwarzmeier, J.L.; Symon, K.R. (Courant Institute of Mathematical Sciences, New York University, New York, New York 10012). *J. Math. Phys. (N.Y.);* **20**: No. 6, 979-983(Jun 1979).

The following theorem is proved. Let D (ω) be an operator with eigenvalues and eigenfunctions {d/sub k/(ω), ν/sub k/(ω) }, where ω is a complex parameter. Given a complex number d/sub k/ 0, let ω_0 be such that d/sub k/(ω_0) =<nu-tilde/sub k/(ω_0) vertical-barD (ω_0) vertical-barν/sub k/(ω_0) >=d/sub k/0, where nu-tilde/sub k/(ω_0) is the dual eigenfunction to ν/sub k/(ω_0). Suppose psi and psi-tilde approximate ν/sub k/(ω_0) and nu-tilde/sub k/(ω_0), respectively, to order ϵ. Then, if D (ω) is analytic in ω in the neighborhood of ω_0, and if ω′ is such that <psi-tildevertical-barD (ω′) vertical-barpsi>=d/sub k/0, ω′ usually will approximate ω_0 to order ϵ^2. By applying this theorem it is shown that roots of the inhomogeneous plasma dispersion relation usually will be accurate to second order if the associated normal modes and their duals are known merely to first order. The theorem can also be applied to solutions of the dispersion relation in a truncated function space.

42004 **Methods of series analysis. III. Integral approximant methods.** Hunter, D.L.; Baker, G.A. Jr. (Physics Department, St. Francis Xavier University, Antigonish, Nova Scotia B2G 1C0, Canada). *Phys. Rev., Sect. B. Condens. Matter;* **19**: No. 7, 3808-3821(1 Apr 1979).

We discuss the approximation of functions by the solution of certain differential equations derived from their power-series coefficients. We call these approximations integral-curve approximants, or more simply integral approximants, and find that they include as special cases many of the currently used methods. We investigate their invariance and singularity properties, and test the power of the first-order ones on a series of known functions. These integral approximants do as well, and often better, than any of the now current (nonexact) methods of approximation. We have applied them to the low-temperature Ising-model susceptibility and find, for the first time by series methods, reasonably good evidence that the low-temperature critical index is equal to the high-temperature one, as expected from the scaling and renormalization-group approaches.

42005 **Nonlinear wave equations and differential geometry.** Marinov, M.S. (Institute of Theoretical and Experimental Physics, State Committee for the Use of Atomic Energy). *Sov. J. Nucl. Phys. (Engl. Transl.);* **28**: No. 1, 125-131(Jul 1978).

Applications of the methods of differential geometry to Sine-Gordon type equations are reviewed. The basic results of the theory of surfaces in Euclidean space are briefly outlined. Following an idea of Lund and Regge it is shown that the study of the motion of a reference frame along a surface leads to a certain class of solvable two-dimensional relativistic field theories.

FUSION ENERGY

42006 (KFTI—77-14) **Bibliography on the stochastic processes in plasma and related problems. Issue 7. (3001-3500 items).** Polovin, R.V. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1977. 36p. (In Russian and English). Dep. NTIS (US Sales Only), PC A03/MF A01.

The bibliographic index on the stochastic processes in plasma and related problems embraces 500 titles of papers published primarily in the 70-ies all over the world. The majority of papers deals with trapped particles, nonlinear waves in plasma, linear and nonlinear fluctuations.

PLASMA RESEARCH

REFER ALSO TO CITATION(S) 41484

PLASMA CONFINEMENT AND HEATING

42007 (CNEN-RT/FI—78-13) **Slowing down of alpha particles in a Tokamak fusion reactor. Numerical and analytical results.** Bittoni, E.; Felician, L. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1978. 70p. Dep. NTIS (US Sales Only), PC A04/MF A01.

The dynamics of alpha particles in a Tokamak is the main subject of this study: particular attention is devoted to orbit topology and to the fraction of alpha particles not contained in the reactor. A slowing-down model (S.D.M.) is presented, constituting a first improvement of the single orbit model (S.O.M.) for energy deposition in the plasma.

42008 (EUR—5735, pp 303-326) **Compact experiments for α-particle heating.** Coppi, B. 1978.

From School on tokamak reactors for breakeven; Erice, Italy (21 Sep 1976).

Recent experiments, and scalings deduced from them, have indicated that relatively high density plasmas can be produced and well confined in toroidal configurations capable of sustaining high current densities without inducing macroscopic instabilities. Here we propose to develop a line of compact devices sustaining sufficiently high plasma currents to confine the 3.5 MeV α-particles that are produced in D-T reactions. This line is proposed as a parallel program to the development of large volume Tokamaks which is being undertaken on a worldwide basis.

42009 (EUR—5735, pp 511-528) **Lecture 1. on auxiliary heating in 'Breakeven Tokamaks'.** Sheffield, J. (UKAEA Research Group, Abingdon. Culham Lab.). 1978.

From School on tokamak reactors for breakeven; Erice, Italy (21 Sep 1976).

We may identify two main areas where auxiliary heating may be used in breakeven Tokamak reactors. (1) In the start up phase of a Tokamak reactor, having a thermal energy distribution, auxiliary heating is required to bridge the gap between the ohmic state where the temperature will probably be approximately 1 keV, and the ignited condition where T>5 keV. (2) In two component and three component systems, auxiliary power is required to maintain a non-thermal ion distribution. I will follow a similar line to that taken in the above papers and will assess the auxiliary heating requirements of a 'Breakeven Tokamak' producing approximately 500 MW of thermal power, using the D-T cycle. I will consider two and three component systems insofar as they may be used during the start up phase, but not as reactor systems in their own right. In the first lecture I will not discuss details of the heating methods. Symbols and units are given in the Appendix.

42010 (KIYI—77-20) **Instability of energy balance and particle number in thermonuclear plasma.** Reznik, S.N. (AN Ukrainskoj SSR,

Kiev. Inst. Yadernykh Issledovanij). 1977. 11p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

The features of stationary solutions of energy balance and particle number in thermonuclear plasma are studied using the differential equation qualitative theory. The study is carried out for some dependences of plasma energy confinement time tausub(E)(n,T) upon concentration n and temperature T. It is shown that at tausub(E) approximately Tsup(-1) a periodic thermonuclear reaction process is possible.

42011 (N—79-10898) **Two component plasma vortex approach to fusion.** Ikuta, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Sep 1978. 14p. NTIS PC A02/MF A01.

Two component operations of the field reversed theta pinch plasma by injection of the energetic ion beam with energy of the order of 1 MeV is considered. A possible trapping scheme of the ion beam in the plasma is discussed in detail.

42012 (PPPL—1539) **Stochasticity and superadiabaticity in radiofrequency plasma heating.** Stix, T.H. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Apr 1979. Contract EY-76-C-02-3073. 52p. Dep. NTIS, PC A04/MF A01.

In a plasma subject to radiofrequency fields, it is only the resonant particles - comprising just a minor portion of the total velocity distribution - which are strongly affected. Under near-fusion conditions, thermalization by Coulomb collisions is slow, and noncollisional stochasticity can play an important role in reshaping f(v). It is found that the common rf interactions, including Landau, cyclotron and transit-time damping, can be fitted in a unified manner by a simple two-step one-parameter (ϵ) mapping which can display collision-free stochastic or adiabatic (also called superadiabatic) behavior, depending on the choice of ϵ. The effect on the evolution of the space averaged f (x,v,t) is reasonably well described by a pseudo-stochastic diffusion function, D/sub PS/(v,ϵ) which is the quasilinear diffusion coefficient but with appropriate widening of the delta-function spikes. Coulomb collisions, leading to D/sub Coul/(v) which may be added and directly compared to D/sub PS/(v,ϵ), are introduced by Langevin terms in the mapping equations.

42013 **Betatron resonance instabilities in axisymmetric field-reversed systems.** Finn, J.M.; Sudan, R.N. (Laboratory of Plasma Studies, Cornell University, Ithaca, New York 14853). *Phys. Fluids;* **22**: No. 6, 1148-1153(Jun 1979).

The effect of betatron resonances of the axis encircling, or ring, particles on the low frequency hydromagnetic stability of field reversed configurations is studied. It is found that modes with phase velocity parallel to the ring current are destabilized, and those with phase velocity opposite to the current are damped. For fully field reversed systems with moderate to large aspect ratio, the modes can grow on a hydromagnetic time scale. For rings with a smaller degree of field reversal, or with aspect ratio near unity, the growth rate is exponentially smaller.

42014 **Effect of beam scattering on plasma heating with relativistic electron beams.** Sethian, J.D.; Ekdahl, C.A. (Laboratory of Plasma Studies, Cornell University, Ithaca, New York 14850). *Phys. Rev. Lett.;* **42**: No. 11, 711-714(12 Mar 1979).

A fully ionized plasma column was heated with a relativistic electron beam. Experiments in which plasma heating was dominated by the beam-plasma two-stream interaction demonstrated a scaling of energy deposition with the beam-to-plasma density ratio and the beam angular scatter in accordance with a theorectial model of the two-stream instability. Beam-to-plasma energy-transfer efficiencies exceeding 25% and plasma electron temperatures of 600 eV were observed.

42015 **Nonlinear absorption of the emission from a dye laser in a laser spark.** Koval'chuk, Y.V.; Komissarova, I.I.; Ostrovskaya, G.V. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **23**: No. 10, 1179-1182(Oct 1978).

An experimental and theoretical study is reported of the nonlinear absorption of emission from a dye laser at the wavelength of the Hα line in a laser-induced spark in hydrogen. This effect can be used to measure relaxation times in the plasma.

42016 **Experimental research on Soviet tokamaks.** Bobrovskii, G.A.; Golant, V.E. (I. V. Kurchatov Institute of Atomic Energy, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **4**: No. 5, 540-547(Sep 1978).

The most important results obtained in research on Soviet tokamaks in 1976 and 1977 are reviewed. The work was focused on the behavior of impurities, the disruptive instability, auxiliary heating methods, and the electron energy distribution.

42017 **Plasma energy balance in the L-2 stellarator with ohmic heating.** Akulina, D.K.; Andryukhina, E.D.; Berezhetskii, M.S.; Grebenshchikov, S.E.; Voronov, G.S.; Sbitnikova, I.S.; Fedyanin, O.I.; Khol'nov, Y.V.; Shpigel', I.S. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **4**: No. 5, 569-575(Sep 1978).

Plasma energy balance experiments in the L-2 stellarator are reported. The plasma produced with a toroidal magnetic field of 9—16 kG and an ohmic-heating current of 10—20 kA has the following properties: electron density, (1—1.5) x10^{13} cm^{-3}; central electron temperature, 300—600 eV; central ion temperature, 100—120 eV; and average energy density, 6x10^{16} eV/cm^3. The total energy confinement time of the plasma is 8—10 msec. The average thermal conductivity is less than the Bohm value by a factor of 60—80. The variations in the basic plasma properties as functions of ohmic-heating current, plasma density, and magnetic field are reported.

42018 **Maximum equilibrium plasma pressure in a high-shear stellarator.** Danilkin, I.S. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **4**: No. 5, 576-581(Sep 1978).

An improved estimate is offered for the equilibrium plasma pressure in a stellarator. In a high-shear stellarator, the maximum value, β/sub e/=$8\pi p/b^2$, turns out to be nearly an order of magnitude higher than the values found by the conventional approach, in which the large gradient in the poloidal component of the magnetic field is either ignored or taken into account inadequately. The possibility of increasing the value of β/sub e/ in a stellarator is discussed.

42019 **Thermalization of a two-stream plasma.** Alipchenkov, V.M.; Konkashbaev, I.K.; Ryl'tseva, T.V.; Ulinich, F.P. (I. V. Kurchatov Institute of Atomic Energy, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **4**: No. 5, 586-588(Sep 1978).

Improvements on the theory of two oppositely directed plasma streams are obtained by improving the calculation of the friction force between the two streams. (AIP)

42020 **Plasma-surface interactions in Q-enhanced mirror fusion systems.** Post, R.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *J. Nucl. Mater.;* **76**: No. 77, 12-126(1978).

From 3. international conference on plasma surface interactions in controlled fusion devices; Abingdon, UK (3 - 7 Apr 1978).

Two approaches to enhancement of the Q(energy gain) factor of mirror systems are under study of Livermore. These include the Tandem Mirror and the Field Reversed Mirror. Both of these new ideas preserve features of conventional mirror systems as far as plasma-wall interactions are concerned. Specifically in both approaches field lines exit from the ends of the system and impinge on walls located at a distance from the confinemnt chamber. It is possible to predict some aspects of the plasma-surface interactions of TM and FRM systems from experience obtained in the Livermore 2XIIB experiment. In particular, as observed in 2XIIB, effective of the plasma from thermal contact with the ends owing to the development of sheath-like regions is to be expected. Studies presently underway directed toward still further enhancing the decoupling of the plasma from the effects of plasma surface interactions at the walls are discussed, with particular reference to the problem of minimizing the effects of refluxing secondary electrons produced by plasma impact on the end walls.

PLASMA DIAGNOSTICS

REFER ALSO TO CITATION(S) 41130

42021 (N—79-10901) **Thomson scattering measurement in JIPP T-II device.** Kawahata, K.; Hamada, Y.; Yasuda, A.; Miyamoto, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Jul 1978. 23p. NTIS PC A02/MF A01.

Measurements of electron temperature and density in J.I.P.P. T-II device were made by Thomson scattering of ruby laser light. It was found that the plasmas of electron temperature in the range of 0.5 to 1.3 keV and of electron density in the range of 1.5 to 10 x 1013/cc were confined. The overall layout of laser measurement system used in J.I.P.P. T-II device and the examples of the measurements are described.

42022 (Rijnhuizen—78-109) **Measurement of microwave spectra from a high-density toroidal discharge with current-driven turbulence.** Van Andel, H.W.H. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Inst. voor Plasma-Fysica). Mar 1978. 7p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Microwave radiation measurements in the region ωsub(pi)<<ω<ωsub(ce) in a high-density (ωsub(pe)>>ωsub(ce)) tokamak with turbulent skin heating show evidence of a Cerenkov beam-plasma instability during the first few microseconds of the heating pulse. It is proposed that the instability is caused by the interaction of populations of freely accelerated electrons with the bulk of the plasma, and corresponds to the unstable propagation of oblique whistlers along group-velocity resonance cones. Measured microwave spectra and their interpretation are presented.

42023 Construction, calibration, and application of a compact spectrophotometer for EUV(300-2500 A) plasma diagnostics. Moos, H.W.; Chen, K.I.; Terry, J.L.;Fastie, W.G. (Johns Hopkins University, Physics Department, Baltimore, Maryland 21218). *Appl. Opt.;* **18**: No. 8, 1209-1216-1(15 Apr 1979).

A 400-mm normal incidence concave grating spectrophotometer, specifically designed for plasma diagnostics, is described. The wavelength drive, in which the grating is translated as well as rotated, is discussed in detail; the wavelength linearity of the sine drive and methods of improving it are analyzed. The instrument can be used in any orientation, is portable under vacuum, and quite rugged. The construction techniques utilized produce a high quality vacuum making the instrument compatible with both high purity plasma devices and synchrotron radiation sources. The photometric sensitivity calibration was found to be very stable during extended use on high temperature plasma devices. The applications of the instrument to diagnose plasmas in two tokamaks and a mirror device are decribed. A facility used for photometric calibration of extreme ultraviolet ($\lambda > 300$-A) spectrophotometers against NBS standard diodes is described. The instrumental calibration obtained using this facility was checked by using synchrotron radiation from SURF II; very good agreement was observed.

42024 Holographic interferometry of a high-energy-density exploding lithium wire plasma. Rockett, P.D.; Bach, D.R. (The University of Michigan, Ann Arbor, Michigan 48109). *J. Appl. Phys.;* **50**: No. 4, 2670-2674(Apr 1979).

Single-wavelength holographic interferometry was applied to the study of an exploding lithium wire plasma. The wire was 1 mil in diameter, extruded in vacuum. A holographic-quality ruby-laser probe produced a 16-ns FWHM pulse at $\lambda = 694.3$ nm with 45 mJ in the TEM_{00} mode. A temperature-controlled resonant reflector restricted laser operation to essentially a single-longitudinal mode. Linear charge density measured from Abel inverted interferograms implied that a significant amount of neutral or un-ionized lithium was present in a cold core. Peak electron density reached 1.4×10^{19} e$^-$/cm^3 and $2 <$ T/sub e/ < 10 eV, but significant neutral contribution prevented accurate electron density determination near the core. Three characteristic periods of plasma development were identified and compared to time-resolved streak photographs of the luminous plasma front and optical spectra. Of special interest, a period of localized neutral "cloud" formation was observed with densities reaching 8×10^{17} cm^{-3}, forming after self-pinching and before peak discharge current.

42025 Determination of Fe charge-state distributions in the Princeton large torus by Bragg crystal x-ray spectroscopy. Hill, K.W.; Goeler, S.v.; Bitter, M.; Campbell, L.; Cowan, R.D.; Fraenkel, B.; Greenberger, A.; Horton, R.; Hovey, J.; Roney, W.; Sauthoff, N.R.; Stodiek, W. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Rev., A;* **19**: No. 4, 1770-1779(Apr 1979).

A curved-crystal Bragg x-ray spectrometer has been used to measure Kα or 1s-2p radiation from highly stripped Fe XVIII-Fe XXV impurity ions in the Princeton large torus tokamak. The spectrometer has sufficient energy resolution ($<$ or $\approx$ 4 eV at 6400 eV) to distinguish between the different ionization states of iron by measuring the energy shift of the Kα x rays. The measured wavelengths agree well with theory and with spectra from solar flares and from laser-produced plasmas. The distribution of Fe charge states in the center of the discharge has been inferred from a comparison of the measured x-ray spectrum with theory. The shape of the spectrum depends strongly on electron temperature (T/sub e/) in the range T/sub e/ = 800—1500 eV. Within the factor of 2 uncertainty in L-shell ionization cross sections, measured intensities agree with theory, which is based on coronal equilibrium, indicating that the ion lifetime in the center of the plasma is approximately equal to or greater than the equilibration time.

42026 Electrical portion of multichannel system for optical diagnostics of pulsed plasma sources. Bayunov, V.I.; Demidov, V.I.; Lakutin, V.A.; Lavrentyuk, V.E.; Mironov, I.S.; Podmoshenskii, I.V.; Sobolev, V.F. *Sov. J. Opt. Technol. (Engl. Transl.);* **45**: No. 10, 654-658(Oct 1978).

This paper discusses the group of electronic instruments and modules of a system for the comprehensive diagnostics of the evolution processes of plasma bodies in the 5000—60,000 K interval at times of 10^{-6}-10^{-2} sec, adapted for the conditions of a one-time test and simultaneous functioning with the pulsed current generator in the power supply for a high-current electrical discharge. The operation of the measurement complex is illustrated for the example of the diagnostics of a layered pulsed discharge.

42027 Low-frequency impedance of a probe in a dense plasma. Baksht, F.G. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **23**: No. 10, 1153-1156(Oct 1978).

The impedance of a spherical probe is found as a function of the frequency, Z (ω), in a dense plasma in which the sheath and the mean free path are both small in comparison with the probe dimensions. The analysis is carried out for frequencies ω of the order of the reciprocal of the ion diffusion time in the probe sheath. The ion diffusion coefficient in the plasma can be determined from the measured frequency dependence Z (ω). The space potential can be determined from the sign change of the reactive component of Z (ω) associated with the change in the polarity of the voltage drop in the sheath.

42028 Auger-spectroscopic study of the discharge chamber surface in the T-4 tokamak. Vorob'ev, A.V.; Mirnov, S.V.; Semenov, I.B.; Stepanchikov, V.A. (I. V. Kurchatov Institute of Atomic Energy, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **4**: No. 5, 547-549(Sep 1978).

A PHI-545A Auger microanalyzer has been used to analyze the composition of the thin films which are deposited on various parts of the discharge chamber in the T-4 tokamak. The samples taken from the T-4 were placed in the chamber of the microanalyzer (residual pressure $\sim 2 \times 10^{-10}$ torr) and analyzed as a layer-by-layer sputtering by argon ions was carried out. After several thousand working cycles of the tokamak, a film of the metals in the structural materials of the chamber was deposited on the surface of the graphite limiter. Analysis of the deposition suggests that the mechanism for damage to the wall by the plasma becomes less effective with distance from the boundary of the hot plasma and that this mechanism involves penetration by the plasma 2—4 cm into the shadow of the limiter. The presence of chemically bound carbon in the films (as metal carbides) and the increase in the concentration of hydrocarbons C/sub n/H/sub m/ in the working gas after the discharge suggest that a large part of the sputtered carbon from the limiter is carried out of the discharge chamber in the form of gaseous compounds. This result points to an important advantage of graphite as a structural material for a fusion reactor.

42029 Electron cyclotron emission in the L-2 stellarator. Akulina, D.K.; Khol'nov, Y.V. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **4**: No. 5, 565-568(Sep 1978).

The emission at 2ω/sub He/ in the L-2 stellarator has been studied experimentally during ohmic heating. At a low plasma density, n-bar/sub e/ $< 4 \times 10^{12}$ cm^{-3}, synchrotron radiation of runaway electrons is observed. At a high plasma density, n-bar/sub e/ $>$ or $= 7 \times 10^{13}$ cm^{-3}, the emission is thermal and can be used to determine T/sub e/ and T/sub e/ (r).

42030 Detection of plasma fluctuations using a homodyne method with a CO_2 laser. Bulanin, V.V.; Zhilinskii, A.P.; Petrov, A.V.; Ushakov, S.N. (M. I. Kalinin Polytechnical Institute, Leningrad). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **4**: No. 9, 443-444(Sep 1978).

A promising method for studying fluctuations of electron density in large plasma devices exploits raman scattering of a laser beam. An optical homodyne arrangement for analysis of the scattered beam from a carbon dioxide laser, over a broad range of solid angles, is described.(AIP)

PLASMA KINETICS - GENERAL

REFER ALSO TO CITATION(S) 41129

42031 (IPP—3/40) Cross sections and rate coefficients for the interaction of a monoenergetic neutral lithium beam with a Maxwellian plasma. McCormick, K. (Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)). Jan 1978. 39p. Dep. NTIS (US Sales Only), PC A04/MF A01.

Cross sections and rate coefficients for the interaction of a monoenergetic neutral lithium beam with a Maxwellian plasma are presented. Experimentally determined cross sections from the literature are used for the ionization of lithium atoms by electron impact and by charge exchange on protons as well as for the excitation of the Li(2s-2p) line by electrons. The analytical expressions of Cryzinski are employed to compute the cross sections for the ionization of lithium by ions and for the excitation of the Li(2-2p) line by ions. The calculations are done for electron and proton temperatures in the range 10 eV to 10 keV with the lithium beam energy being varied as a parameter between 4 and 100 keV.

42032 (N—79-10900) Institute of plasma physics. Annual review, April 1977—March 1978. (Nagoya Univ. (Japan)). 1978. 185p. NTIS PC A09/MF A01.

The construction and successful operations of the RFC-XX, the SPAC-V toroidal device, the Phoebus II electron beam generator, and the Nagoya bumpy torus are reported. Research activities discussed include radio frequency confinement, high beta pinch plasmas, high energy beam experiments, atomic processes, technology and applied physics, plasma theory and computations, plasma diagnostics, and on-line systems. Common centers for processing and

storing plasma physics and nuclear fusion data are described, as well as the MVA flywheel power supply facility.

PLASMA KINETICS - EXPERIMENTAL

42033 Physics of a hollow arc cathode with a highly ionized dense plasma. Dyuzhev, G.A.; Startsev, E.A.; Yur'ev, V.G. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **23**: No. 10, 1157-1163(Oct 1978).

The physics in a hollow cathode operated in the arc mode is studied. The distributions of plasma parameters in the cathode cavity are measured. The primary emission mechanism is thermionic emission from the surface of the cathode, which is in contact with the highly ionized plasma. The current flow, the energy balance in the hollow cathode, and the dependence of plasma parameters on pressure and the emission current are studied. The depth to which the plasma penetrates the cathode cavity depends on the applied voltage, the gas pressure, and the emission current density.

42034 Enhanced diffusion of a magnetized plasma in a dielectric chamber with a thermionic emitter. Zhilinskii, A.P.; Kuteev, B.V. (M. I. Kalinin Leningrad Polytechnical Institute). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **23**: No. 10, 1168-1171(Oct 1978).

It is shown experimentally that when a partially ionized plasma in a magnetic field is in contact with a thermionic emitter in a dielectric chamber a substantial reduction in the lifetime of the charged particles occurs because the ambipolar diffusion process no longer operates. The experiments have been carried out in a helium afterglow with p=0.1 torr at magnetic fields up to 3 kOe. The effect of thermionic emission on plasma decay is only observed in the presence of a longitudinal current comparable to the current that corresponds to unipolar electron diffusion. Good contact between the emitter and the plasma occurs at a strong magnetic field (Ω/sub i//ν/sub i/> or ≈2). A qualitative description of the observed effect is given.

42035 Formation of a relativistic electron beam in a plasma focus, its dynamics, and its interaction with a flat target. Gribkov, V.A.; Nikulin, V.Y.; Semenov, O.G.; Sklizkov, G.V. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **4**: No. 5, 589-594(Sep 1978).

Experiments on the properties and dynamics of a relativistic electron beam formed in a plasma focus are discussed. The beam is focused in the plasma of the discharge and reaches a size r< or ≈1mm (correspondingly, the current density is J~10^8 A/cm^2, and the energy flux is q> or ≈10^{12} W/cm^2). The beam interacts effectively with the plasma "corona" at the anode which is formed by the intense thermal flux from the pinch plasma.

42036 Quasisteady plasma accelerator with an anode sheath. Berezov, D.V.; Demidenko, I.I.; Lomino, N.S.; Ovcharenko, V.D.; Padalka, V.G. (Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR, Khar'kov). *Sov. J. Plasma Phys. (Engl. Transl.);* **4**: No. 5, 595-597(Sep 1978).

The characteristics of a quasisteady axial Hall accelerator with an anode sheath have been studied. The properties of the plasma produced are very sensitive to the rate of injection of the working gas (argon). At injection rates below a certain critical value N/sub a/, there is an "acceleration mode"; at N>N/sub a/ there is an anomalous low-voltage operation of the source. In the acceleration mode the beam current density reaches 15 mA/cm^2 at a distance ~10 cm from the accelerator. The angular divergence of the beam does not exceed 5°. The average energy of the accelerated ions is proportional to the voltage applied to the accelerator, V/sub acc/, and has the value ~0.5 eV/sub acc/.

42037 Phenomenology of metal influx in Macrotor. Oren, L.; Taylor, R.J. (California Univ., Los Angeles (USA)); Schwirzke, F. (Naval Postgraduate School, Monterey, CA (USA)). *J. Nucl. Mater.;* **76**: No. 77, 12-417(1978).

From 3. international conference on plasma surface interactions in controlled fusion devices; Abingdon, UK (3 - 7 Apr 1978).

Time-space distributions of metal influx were studied. The flux is strongly localized at the areas of intersection of the magnetic surfaces and the wall. This results, in general, in a lack of poloidal symmetry. The experimental results show that the metal influx is caused by ions escaping from the magnetic surfaces to the wall, accelerated by the sheath potential. Laser probing of the wall shows that metal impurities are loosely bound on the surface. Laser induced desorption, combined with spectroscopy, represents a new method of measuring impurity levels on the surface.

42038 Surface interactions and conditioning techniques in tokamaks. Taylor, R.J. (California Univ., Los Angeles (USA)). *J. Nucl. Mater.;* **76**: No. 77, 1-44(1978).

From 3. international conference on plasma surface interactions in controlled fusion devices; Abingdon, UK (3 - 7 Apr 1978).

It now appears that the removal of oxygen from the surfaces of a fusion device requires a carefully generated hydrogen plasma where chemical effects are allowed to dominate. Two critical parameters must be considered: (1) the plasma temperature, and (2) the plasma-wall sheath potential. Increasing either of these two beyond certain values reduces the rate at which oxygen is removed (in the form of H_2O). For best results, the bulk outgassing must be reduced by baking the chamber at moderate temperatures as in other high vacuum applications. Oxygen applied to the surfaces result in a corresponding increase in the oxygen level in the plasma, while impurities in the filling gas do not normally play a significant role. Effective surface densities close to 1% of a monolayer have been obtained.

PLASMA KINETICS - THEORETICAL

42039 (EUR—5735, pp 75) **Numerical studies of impurity phenomena.** Duechs, D.F.; Behrisch, R. (Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)). 1978.

From School on tokamak reactors for breakeven; Erice, Italy (21 Sep 1976).

42040 (EUR—5735, pp 77) **Computer studies.** Duechs, D.F. (Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)). 1978.

From School on tokamak reactors for breakeven; Erice, Italy (21 Sep 1976).

42041 (N—79-10899) **Initial particle loadings for a nonuniform simulation plasma in a magnetic field.** Naitou, H.; Tokuda, S.; Kamimura, T. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Sep 1978. 33p. NTIS PC A03/MF A01.

Improved methods for initially loading particles in a magnetized simulation plasma with nonuniform density and temperature distributions are proposed. In the usual guiding center loading, a charge separation coming from finite Larmor radius effects remains due to the difference between the guiding center density and the actual density. The modified guiding center loading presented here eliminates the electric field so generated and can be used for arbitrary density and temperature profiles. Some applications of these methods to actual simulations are given for comparison. The significance of these methods of initial particle loadings is also discussed.

42042 (Rijnhuizen—77-107) **MHD-Equilibrium of weakly elipto-toroidal plasma columns in force-free fields.** Schuurman, W. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Inst. voor Plasma-Fysica). Dec 1977. 24p. Dep. NTIS (US Sales Only), PC A03/MF A01.

In this report ideal MHD-equilibrium configurations on toroidal plasma columns are considered. The sharp boundary model is chosen and the equilibrium equations are solved by a series expansion in the inverse aspect ratio of the metal enclosure. It is argued that calculations are comparatively simple by the use of Kadomtsev-Pogutse coordinates, which are extended to second order. Explicit formulae are derived for the ellipticity of a plasma column surrounded by a vacuum or by a tenuous plasma in a magnetic field with a constant pitch. The dependence of the toroidal shift and the ellipticity on the compression ratio and the poloidal β is discussed.

42043 (SAI—78-964-LJ) **Transport and radiation studies of belt pinches and high-beta tokamaks.** Byrne, R.N.; Chu, C.K. (Science Applications, Inc., La Jolla, CA (USA). Lab. for Applied Plasma Studies). Nov 1978. Contract EY-76-C-03-1028. 24p. (LAPS—47). Dep. NTIS, PC A02/MF A01.

Transport and radiation studies are performed for 2:1 ratio elliptical cross-section plasmas, using the toroidal geometry diffusion code G2M. The Torus I and II machines at Columbia are used as models. From the viewpoint of radiation, these machines represent the general classes of cold pinch-tokamaks (T ~ 10 eV) and hot pinch-tokamaks (T ~ 100 eV), which are qualitatively different because of oxygen impurities. Two types of profiles are studied: parabolic density and temperature distributions, and force-free current profiles, with density peaked near the center and temperature almost flat.

42044 (UWFDM—269) **Nonadiabatic particle motion in the magnetotail.** Howard, J.E. (Wisconsin Univ., Madison (USA). Dept. of Nuclear Engineering). May 1979. Contract EY-76-S-02-2272. 24p. Dep. NTIS, PC A02/MF A01.

An analytic formula is derived for nonadiabatic jumps in the magnetic moment ν /sub perpendicular to/^{3}/B for proton orbits in a parabolic magnetic field resembling the high-β field in the neutral sheet. The results show that only orbits with large pitch angle (α > 77°) are adiabatic and predict a neutral sheet thickness close to 1.5

R/sub e/. These orbits are shown to possess a near-integral resonance between their longitudinal (bounce) and transverse (gyrational) motion.

42045 Stability theory of a relativistic electron beam-plasma system with finite geometries. Tajima, T. (Department of Physics, University of California, Los Angeles, California 90024). *Phys. Fluids;* **22**: No. 6, 1157-1170(Jun 1979).

An extensive study of the stability of a relativistic electron beam-plasma system in finite (cylindrical) geometries is performed. The analysis is based on the collisionless fluid theory; it accomodates both the finiteness and relativistic effects by employing the full set of Maxwell's equation. Finite boundaries of the beam and plasma are found to have a stabilizing effect on the two stream instability under a static magnetic field. The instability tends to have a smaller growth rate when the plasma radius becomes smaller and the magnetic field becomes stronger. In the extreme case of an infinite magnetic field, the marginal beam density for stability is a sharply increasing function of the relativistic factor γ_0 and the inverse of the plasma radius, and a mildly decreasing function of the plasma electron density. Surface modes of the filamentation instability in cylindrical geometry for a thin hollow beam are also examined. Possible applications of the present theory to the long solenoid reactor configuration and the runaway electron problem in a low densith regime of a tokamak are discussed.

42046 Staircase model for magnetohydrodynamic spectrum and global instabilities in the Elmo bumpy torus. Nelson, D.B.; Spies, G.O. (Courant Institute of Mathematical Sciences, New York University, New York, New York 10012). *Phys. Fluids;* **22**: No. 6, 1182-1188(Jun 1979).

In the staircase model a continuous equilibrium is approximated by a discontinuous one with jump surfaces separating regions of constant pressure, density, and magnetic rotation number. The dispersion relation, giving the growth rates or frequencies of eigenmodes of the linearized motion as solutions of a finite matrix eigenvalue problem, is derived for arbitrary axisymmetric straight staircase equilibria with no azimuthal magnetic field and with weak, long, and thin periodic mirrors. This relation is shown to describe global modes accurately, thus being well suited to obtaining their dependence upon the pressure and density profile with minimal numerical effort. Application to hollow pressure profiles typical of the Elmo bumpy torus yields global instabilities with growth rates too large to be compatible with observations, indicating that kinetic effects must be invoked to explain even the large-scale behavior of this device.

42047 Ohm's law in the banana regime for axisymmetric toroidal systems with noncircular cross section. Morozov, D.K. (Energiya Scientific and Industrial Organization, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **4**: No. 5, 550-553(Sep 1978).

Axisymmetric toroidal configurations of a plasma with singly charged ions are studied. A generalized Ohm's law, averaged over a magnetic surface, is derived for the banana regime for magnetic surfaces of arbitrary cross section. The effective longitudinal conductivity and the bootstrap current are calculated. The bootstrap current is affected by both the stress tensor and the neoclassical friction force.

42048 Variable-inversion method in MHD-equilibrium problems. Vabishchevich, P.N.; Degtyarev, L.M.; Favorskii, A.P. (Institute of Applied Mathematics, Academy of Sciences of the USSR, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **4**: No. 5, 554-556(Sep 1978).

A variable-inversion formulation is proposed for MHD-equilibrium problems. The new coordinates are the flux function and the orthogonal surfaces. The coordinates of the magnetic surfaces are unknowns which satisfy two elliptical equations. This coordinate system is used for a numerical solution of certain MHD-equilibrium problems for given magnetic fluxes.

42049 Reconnection of magnetic surfaces and current mixing at the onset of a tokamak discharge. Dnestrovskii, Y.N.; Kostomarov, D.P.; Pereverzev, V.G.; Tarasyan, K.N. (I. V. Kurchatov Institute of Atomic Energy, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **4**: No. 5, 557-558(Sep 1978).

The current rise in a tokamak is simulated numerically. The reconnection of the magnetic lines of force in the case of several resonant surfaces can lead to a disruption of the current-density distribution in the skin layer, and it can lead to a rapid penetration of the current into the plasma.

42050 Kinetics of neutral atoms near the wall of a tokamak discharge chamber. Stakhanov, I.P.; Igitkhanov, Y.L. (I. V. Kurchatov Institute of Atomic Energy, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **4**: No. 5, 559-564(Sep 1978).

The problem of the neutral atom distribution in the temperature gradient near a wall is broken up into two parts. It is assumed that the charge exchange rate is much higher than the ionization rate. Near the wall, within a distance on the order of the mean free path, the temperature gradient and the ionization can be ignored, and the kinetic equation incorporating charge exchange can be solved. This solution is used to find the distribution function of the atoms incident on the wall from the plasma and to find the plasma density distribution near the wall. The problem of the atom distribution far from the wall is solved with a given plasma-temperature gradient. The asymptotic density found in the first problem is used as a boundary condition. It is shown that the temperature gradient can strongly influence the plasma density distribution. The conditions under which a substantial number of atoms can reach the interior of the discharge, despite ionization, are discussed.

42051 Plasma—field boundary with particle loss. Konkashbaev, I.K.; Landman, I.S.; Ulinich, F.R. (I. V. Kurchatov Institute of Atomic Energy, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **4**: No. 5, 582-585(Sep 1978).

The formation of the plasma—field boundary (skin layer) is studied for magnetic confinement systems with $\beta = 1$. Two mechanisms are involved in the formation of the skin-layer structure: the mutual diffusion of the plasma and the field, which tends to thicken the boundary, and the escape of particles trapped in the skin layer along the magnetic lines of force through the magnetic mirror, which tends to contract the boundary. It is shown that the contraction of a thick boundary occurs in a time on the order of the characteristic time for ion—ion collisions. The ion and electron temperatures change substantially. The ultimate thickness of the skin layer is larger than the hybrid gyroradius but smaller than the ion gyroradius, and it varies slightly with the initial temperatures.

42052 Spatial separation by mass in a rotating weakly ionized plasma. Kurko, O.V. (I. V. Kurchatov Institute of Atomic Energy, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **4**: No. 5, 598-602(Sep 1978).

Mechanisms for the spatial separation of neutral particles of different masses in a weakly ionized plasma rotating in crossed electric and magnetic fields are studied. For a low-density gas, in which the mean free path of the neutrals is longer than the transverse dimension of the apparatus, the separation of the neutrals due to the revolution should increase with increasing gas density. For a dense gas, in which the neutral mean free path is much shorter than the dimensions of the apparatus, other separation mechanisms can come into play and supplement that associated with the revolution of the neutrals. These new mechanisms are consequences of the radial temperature gradient. As long as the ions are magnetized, an increase in the gas density at a constant degree of ionization reduces the relative importance of viscous forces, which tend to retard the rotation of the neutral gas, in comparison with the friction forces between the neutrals and the ions. The efficiency of the separation of neutrals due to the rotation should increase. The condition of magnetized ions, however, seriously restricts the neutral density. Inhomogeneity of the heat sources and the presence of cooling walls leads to the appearance of a temperature gradient, which causes a thermodiffusion separation of the neutrals of various masses. If the cross sections for ionization of the different components are very different, a spatial-separation mechanism due to the difference in the heating of the different components comes into play in a certain density range.

42053 Bremsstrahlung from a plasma expanding into vacuum. Grigor'ev, V.G.; Silakov, V.P.; Fetisov, V.S. (Moscow Engineering Physics Institute). *Sov. J. Plasma Phys. (Engl. Transl.);* **4**: No. 5, 631-633(Sep 1978).

The bremsstrahlung from a planar slab of a hot, dense plasma which is expanding into vacuum is studied. Equations are derived for the bremsstrahlung intensity when the plasma slab traversed by the rarefaction wave is optically thin and optically thick.

42054 Electrodynamic characteristics of a nonequilibrium weakly ionized plasma produced by a pulsed ionization source. Medvedev, Y.A.; Metelkin, E.V. (All-Union Scientific-Research Institute of Opticophysical Measurements). *Sov. J. Plasma Phys. (Engl. Transl.);* **4**: No. 5, 644-649(Sep 1978).

The time-dependent distribution function, the mobility, and the conductivity are calculated for the nonequilibrium electrons which result from the slowing in a weakly ionized gas of the monoenergetic electrons from a pulsed source with a uniform spatial distribution in an external electric field. The conditions under which the nonequilibrium weakly ionized plasma has a negative, time-dependent conductivity are studied.

42055 Electron distribution function and kinetic coefficients of a nitrogen plasma. II. Vibrationally excited molecules. Aleksandrov, N.L.; Konchakov, A.M.; Son, E.E. (Moscow Physicotechnical Institute). *Sov. J. Plasma Phys. (Engl. Transl.);* **4**: No. 5, 663-666(Sep 1978).

Cross sections for the electron-nitrogen collisions are calculated assuming the molecules have a Boltzmann distribution with respect to excited states. (AIP)

42056 Drift kinetic equation for toroidal plasmas with large mass velocities. Hazeltine, R.D.; Ware, A.A. (Texas Univ., Austin (USA). Fusion Research Center). *Plasma Phys.;* 20: No. 7, 673-678(Jul 1978).

A drift-kinetic equation is derived which is accurate to first order in the ratio of the Larmor radius to a characteristic length and in which the plasma mass velocity is assumed to be of zeroth order.

PLASMA PRODUCTION

REFER ALSO TO CITATION(S) 41533

42057 (JEN—404) **Self-similar motion of laser half-space plasmas. 2.Thermal wave and intermediate regimes.** Sanmartin, J.R.; Barrero, A. (Junta de Energia Nuclear, Madrid (Spain)). 1978. 21p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The one-dimensional self-similar motion of an initially cold, half-space plasma of electron density n sub(0), produced by the (anomalous) absorption of a laser pulse of irradiation phi = phi sub(0)t/tau(0(<)t(<=)tau) at the critical density n sub(c), is considered; the analysis, which allows for electron heat conduction and ion-electron energy exchange, involves three dimensionless numbers: epsilon identical to n sub(c)/n sub(0) assumed small, Z sub(i) (ion charge number), and a parameter alpha varies as [nsub(0)sup(2)tau/phisub(0)]sup(2/3). For alpha(<<)1 a weak discontinuity develops, separating a thermal wave (where convection is negligible) moving into the undisturbed plasma, from a much thinner isothermal flow expanding into the vacuum. For 1(<<)alpha(<<)epsilonsup(-4/3) there is an isentropic compression flow between a shock, blounding the undisturbed plasma, and a very thin transition layer bounding an expansion flow, much larger in extent than the compression region. In both regimes the critical plane lies far in the expansion tail. The results break down when the density is so small that the plasma becomes collisionless. The analysis is also invalid for alpha too small. Using results previously found for alpha(>>)epsilon sup(-4/3), a qualitative discussion of how plasma behavior changes with alpha, is given.

42058 Measurement of return current in a laser-produced plasma. Benjamin, R.F.; McCall, G.H.; Ehler, A.W. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev. Lett.;* 42: No. 14, 890-893(2 Apr 1979).

A laser-fusion target's support fiber is heated at large distances from the laser plasma principally by Ohmic heating due to an electrical return current. Optical and electrical measurements demonstrate that return-current heating dominates over other heating mechanics such as hot-electron propagation along the fiber, thermal conduction, and line-of-sight plasma radiation.

42059 Laser-beam characteristics of Phoenix, an HF oscillator-amplifier system. Patterson, E.L.; Hays, G.N.; Truby, F.K.; Gerber, R.A. (Sandia Laboratories, Albuquerque, New Mexico 87185). *J. Appl. Phys.;* 50: No. 4, 2643-2646(Apr 1979).

Energy-extraction and beam-quality measurements are reported for Phoenix, Sandia's high-energy HF laser system. The final amplifier in this oscillator-amplifier chain used electron-beam initiation of high-pressure gas mixtures of H_2-F_2-O_2. The oscillator and preamplifier utilized fast electric discharges in SF_6-HI mixtures. Energy-extraction efficiency using this oscillator system was the same as that previously determined using an H_2-F_2-O_2-fueled oscillator which produced a better spectral match to the amplifier but which yielded poorer beam quality. Lateral shearing interferograms showed no significant phase-front degradation of the beam by the final amplifier. Pinhole energy-transmission measurements using a short-focal-length parabolic mirror determined that the focal-spot diameter was 2.7 times the diffraction-limited diameter.

PLASMA INSTABILITIES

42060 High frequency instability of the runaway electron distribution. Choi, D.-I.; Horton, W. Jr. (Texas Univ., Austin (USA)). *Plasma Phys.;* 20: No. 9, 903-920(Sep 1978).

From the quasilinear analysis of the high frequency instability produced by the small perpendicular energy anisotropy of the runaway distribution a phenomenological description of pulsating instability with the associated production of high perpendicular energy electrons is presented. Macroscopic formulas for the period of pulsation and the mean electron energies are obtained.

42061 (EUR—5735, pp 125-150) **MHD equilibrium and stability.** Pfirsch, D. (Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)). 1978.

From School on tokamak reactors for breakeven; Erice, Italy (21 Sep 1976).

The first part of this lecture discusses the influence of current profiles and noncircular cross-sections on the maximum β obtainable in a Tokamak from the MHD equilibrium point of view. The second part treats limitations on such MHD equilibria resulting from various MHD instabilities like external and internal kinks, localized and nonlocalized modes- and axisymmetric instabilities.

42062 (IPP—6/171) **Linear theory of drift-tearing and interchange modes in a screw pinch.** Copenhaver, C. (Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)). Apr 1978. 30p. Dep. NTIS (US Sales Only), PC A03/MF A01.

A drift dispersion relation, as applied to a resistive incompressible plasma in a screw pinch, is derived. This dispersion relation incorporates both drift-tearing and drift-interchange modes and is valid throughout the collisional regime by including kinetic theory factors. The dispersion relation reduces to the drift-tearing dispersion relation in the zero pressure gradient limit, and to the classical resistive dispersion relation in the zero drift limit. The electron temperature gradient instability is still present. Now, however, the introduction of the interchange-drift instability increases the growth rate further above the tearing-drift case.

42063 (N—79-10896) **Dynamic shear stabilization of hydromagnetic kink instabilities in pinch and/or tokamak plasma through a nonlinear mode coupling.** Minami, K.; Hata, H.; Dagiri, S. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Sep 1978. 37p. NTIS PC A03/MF A01.

Dynamic shear stabilization is analyzed from the standpoint of a nonlinear mode coupling between the kink mode and an applied helical RF magnetic field. The analysis is limited to the case of the m = 1 kink mode with long wavelengths in a uniform plasma column with sharp boundary. The dispersion relation of the kink mode in the presence of a small-amplitude helical RF magnetic field is derived. Results suggests that dynamic shear stabilization can be more effective than the prediction of the Mathieu equation.

42064 (N—79-10897) **Dynamic shear stabilization of hydromagnetic instabilities in low-beta plasma column by a frequency near the ion cyclotron frequency.** Minami, K.; Sato, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Sep 1978. 14p. NTIS PC A02/MF A01.

The effectiveness of an axial RF current, whose frequency is not much smaller than the ion cyclotron frequency, on the dynamic shear stabilization of the hydromagnetic instability in low-beta plasmas was analyzed, using the simple model of a uniform plasma column with infinite conductivity. Attention was limited to the case of the m = 1 kink model with long wave lengths. The Mathieu equation, in which the effect of the ion cyclotron motion is taken into account, was derived. It is shown that the dynamic shear stabilization is still effective, even if the frequency of the applied RF current is of the order of the ion cyclotron frequency, which is considerably higher than the frequencies believed to be available in the previous analyses.

42065 (Rijnhuizen—78-108) **Study of equilibrium and stability of high-beta tokamaks surrounded by force-free fields.** D'Ippolito, D.A.; Freidberg, J.P.; Goedbloed, J.P.; Rem, J. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Inst. voor Plasma-Fysica). Mar 1978. 120p. Dep. NTIS (US Sales Only), PC A07/MF A01.

The sharp-boundary model of ideal magnetohydrodynamics is presented in a form readily applicable to axisymmetric, high-β plasmas of arbitrary cross-section. The usual vacuum region outside the plasma is replaced here by a layer of force-free currents, and the influence of force-free currents and cross-sectional shaping on the critical β is studied. Specific results are given for circular, elliptical and racetrack-like cross-sections. A new parameter q^* is introduced in place of the Mercier q, and it is shown that q^* approximately 1 is a reasonable estimate of the toroidal current limitation due to external kink modes in high-β plasmas with noncircular cross-sections.

42066 Stimulated scattering of light by ion modes in a homogeneous plasma: Space-time evolution. Cohen, B.I.; Max, C.E. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Fluids;* 22: No. 6, 1115-1132(Jun 1979).

Stimulated Brillouin scattering, filamentation, and induced Thomson scattering are studied for a coherent electromagnetic plane wave propagating in a uniform plasma. A generalized Green's function is found that describes the impulse response for stimulated scattering by electron and ion modes. Explicit asymptotic Green's functions are calculated for those parametric instabilities involving ion modes or quasi-modes. Special attention is given to whether the instabilities are convective or absolute. For a traveling wave pump in a uniform plasma, Brillouin and induced Thomson backscatter can be absolute, but sidescatter is convective; filamentation of traveling waves is always convective. Spatial growth rates are calculated for convectively unstable modes. Finally, the competition of filamentation and stimulated Brillouin scattering is considered for parameters typical of real laser-fusion experiments.

42067 Warm plasma effects on drift cyclotron loss cone mode. Ng, P.H.; Gladd, N.T.; Liu, C.S. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Fluids;* 22: No. 6, 1141-1147(Jun 1979).

Although plasma density gradients in mirror machines are larger than the theoretical threshold for the drift cyclotron loss cone instability, turbulence is experimentally observed only at low harmonics of the ion cyclotron frequency. The evolution of the drift cyclotron loss cone instability as the loss cone velocity distribution is progressively filled with a warm Maxwellian component is studied. The addition of the warm plasma results in both a lowering of the growth rate and a distortion and narrowing of the frequency spectrum. Under conditions typical of an almost filled loss cone, the numerical result shows that the growth rate is largest for the lower ion cyclotron harmonics and is quite consistent with experimental observations.

42068 Variational calculation of drift wave eigenvalues. Ross, D.W. (Fusion Research Center, The University of Texas at Austin, Austin, Texas 78712). *Phys. Fluids;* 22: No. 6, 1215-1216(Jun 1979).

The validity of the variational calculation of drift wave eigenvalues in plasmas with magnetic shear is reaffirmed by means of a rotation in the complex x plane. Recent criticism of the method is thereby refuted.

42069 Circuit related instability of a plasma discharge. Jensen, T.H.; Moeller, C.P.; Freeman, R.L. (General Atomic Company, San Diego, California 92138). *Phys. Fluids;* 22: No. 6, 1221-1222(Jun 1979).

Electrical circuits involving gas discharges may be unstable because the resistance of the gas discharge tends to decrease with increasing current. A semiquantitative treatment of these instabilities, relevant to tokamak, reversed Z pinch, and similar plasma physics devices, is provided.

42070 Comments on "Magnetohydrodynamic equilibrium of plasma confined in a spherical microwave cavity". Hatch, A.J. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Fluids;* 22: No. 6, 1223-1224(Jun 1979).

These comments summarize the modal dependence of stability of confined overdense and underdense plasma cores in spherical cavities, correct mistakes in pressure distributions and in modal frequencies of plasma-loaded spherical cavities, and point out an inherent degeneracy limitation of perfectly spherical cavities.

42071 Reply to comments by Albert J. Hatch. Woods, C.H. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Fluids;* 22: No. 6, 1224-1225(Jun 1979).

Shape changing effects of spatial variations of electromagnetic fields in the vicinity of small plasma spheres can be avoided by modal combinations giving uniform pressure over the plasma sphere. Practically, it is necessary to design configurations for which the actual modes are sufficiently good approximations to spherical cavity modes. Misprints in Table II and in Eq. (24) are corrected.

42072 "Convective" loss-cone instability is absolute. Gerver, M.J. (Laboratory of Plasma Studies, Cornell University, Ithaca, New York 14853). *Phys. Rev. Lett.;* 42: No. 15, 981-984(9 Apr 1979).

The high-frequency "convective" loss-cone mode in a mirror-confined plasma is shown to be absolutely unstable as a result of wave reflection from the mirror throats, provided that the plasma length is greater than an axial wavelength. Critical lengths for stability are only a few ion gyroradii for fusion parameters, much smaller than previous estimates. This result places serious limitations on the design of mirror fusion reactors, and precludes the possibility of a linearly stable reactor with empty loss cone.

42073 Experimental stabilization of interchange mode by surface line tying. Fornaca, S.; Kiwamoto, Y.; Rynn, N. (Department of Physics, University of California, Irvine, California 92717). *Phys. Rev. Lett.;* 42: No. 12, 772-776(19 Mar 1979).

Experiments are performed in an attempt to stabilize the magnetic-curvature—driven interchange instability (mirror flute mode) using a Q-machine plasma. The stabilization method consists of applying a tenuous plasma blanket, which is line tied to the end wall, around a flute-susceptible higher-density core plasma which has no electrical contact to the wall. By controlling the degree of line tying between the blanket and the wall, the stabilizing effect of surface line tying is demonstrated.

42074 Decay instability of an inhomogeneous plasma containing turning points. Andreev, A.A.; Fedorov, V.I. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. J. Plasma Phys. (Engl. Transl.);* 4: No. 5, 609-613(Sep 1978).

The decay interaction of electromagnetic waves with ion-acoustic waves and Langmuir satellites (red and blue) in an unmagnetized inhomogeneous plasma is studied. In many cases the blue satellite leads to an absolute instability, providing a "feedback" to the region of resonant convective amplification. The instability thresholds and the frequency spectrum of the instabilities are derived. The variation of these properties with the ratio of the characteristic dimension of the temperature inhomogeneity to that of the plasma density is analyzed.

42075 Low-frequency trapped-ion instabilities in a tokamak. Morozov, A.G. (Institute of Geomagnetism, the Ionosphere, and Radio Wave Propagation, Siberian Branch, Academy of Sciences of the USSR, Irkutsk). *Sov. J. Plasma Phys. (Engl. Transl.);* 4: No. 5, 614-617(Sep 1978).

An analysis is carried out of the dynamics of electrostatic perturbations with frequencies near the trapped-ion bounce frequency in an axisymmetric tokamak with a circular cross section. Two types of instabilities are found with growth rates on the order of the oscillation frequency. These instabilities are not very sensitive to shear.

42076 Effect of ion-acoustic turbulence on the parametric instability near the lower hybrid resonance. Asadullin, F.F.; Batanov, G.M.; Sapozhnikov, A.V.; Sarksyan, K.A. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* 4: No. 5, 618-623(Sep 1978).

The parametric instability which occurs near the lower hybrid resonance in connection with the onset of ion-acoustic turbulence in an originally current-free plasma has been studied experimentally. The experimental conditions corresponded to the relations Ω/sub i/very-much-less-thanω/sub L/H$<\omega_0$very-much-less-thanω/sub L/e$<$ or $\approx\Omega$e. The results show a parametric excitation of ion-acoustic noise and of corresponding high-frequency oscillations near the pump frequency over a broad frequency range with a spectrum analogous to that of the ion-acoustic turbulence. The threshold fields for the excitation of the instability increase with increasing level of the acoustic noise in the original plasma, and the steady-state level of acoustic waves in the rf field of the pump wave decreases. The experimental observations show that the acoustic turbulence and the charged-particle velocity distribution affect the parametric wave growth.

42077 Modulation instability of plasma waves excited by relativistic beams. Komilov, K.; Tsytovich, V.N. (V. I. Lenin Tadzhik State University, Dushanbe). *Sov. J. Plasma Phys. (Engl. Transl.);* 4: No. 5, 624-627(Sep 1978).

Relativistic beams can excite intense plasma waves, which are susceptible to modulation instability and lead to strong Langmuir turbulence. It is shown that in cases of practical interest the influence of relativistic beams on the modulation instability is the decisive factor. The growth rates for the modulation instability are found for one-dimensional and "anisotropic" beams.

42078 Instability of a tangential discontinuity in an inhomogeneous plasma. Mishin, V.V.; Moskunov, A.V.; Shkelev, E.I. (N. I. Lobachevskii Gor'kii State University). *Sov. J. Plasma Phys. (Engl. Transl.);* 4: No. 5, 654-656(Sep 1978).

The Kelvin-Helmholtz MHD instability is examined for the case of plasma flow across a magnetic field. (AIP)

42079 Decay instability of Alfven waves in a hot plasma. Erokhin, N.S.; Moiseev, S.S.; Mukhin, V.V. (Khar'kov Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR). *Sov. J. Plasma Phys. (Engl. Transl.);* 4: No. 5, 656-657(Sep 1978).

Using the approximation of two-fluid hydrodynamics, the matrix element of the three-wave interaction is shown to be nonzero in a hot plasma. (AIP)

42080 Decay mechanism for the onset of turbulence. Dubrovin, V.I.; Kogan, V.R.; Rabinovich, M.I. (Institute of Applied Physics, Academy of Sciences of the USSR, Gor'kii). *Sov. J. Plasma Phys. (Engl. Transl.);* 4: No. 5, 658-659(Sep 1978).

The interaction of a linearly amplified wave and its damped subharmonic is studied as a source of turbulence in a nonequilibrium plasma. (AIP)

PLASMA WAVE PHENOMENA

42081 (IAE—2858) Effect of a particle source on the nonlinear evolution of a monochromatic wave. Mikhailovskii, A.B.; Pyatak, A.I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 10p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

The influence of a resonance particle source on the nonlinear monochromatic wave in plasma is investiqated. The cases of the Langmuir frequency in the absence of the magnetic field and the Alfven wave in toroidal geometry of the magnetic field are considered. It is shown that in the presence of the particle source a systematic change of the nonlinear wave amplitude takes place. It is supposed that this effect can be important in the case of fast neutral atom injection into magnetic traps and also for tasks of fast *c*-

particles formed in plasma in thermonuclear reactions and for tasks of fast particle fluxes in the Earth magnetosphere.

42082 (IAE—2859) **Alfven wave excitation by fast particles in adiabatic traps with a finite pressure plasma.** Meerson, B.I.; Mikhailovskii, A.B.; Pokhotelov, O.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 12p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

Studied is the Alfven wave excitation by fast particles in a finite pressure plasma in a longitudinal nonuniform magnetic field. On the basis of the Vlasov kinetic equation the dispersion equation, describing the low frequency Alfven oscillation, is derived. The relationship obtained describes the Alfen wave amplification on account of effects of plasma compressibility in the wave field. The latter is explained by the magnetic field line curvature and by the finiteness of the Larmor fast particles radius. The instability stabilization on trapped particles on account of finite pressure was found. It was established, that bounce-resonance determines the increment oscillations depending on frequency. The results obtained may be used to ensure the appearance of a descreet spectrum of geomagnetic pulsations.

42083 Wavebreaking amplitudes in warm, inhomogeneous plasmas. Kruer, W.L. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Fluids;* **22**: No. 6, 1111-1114(Jun 1979).

The effect of plasma temperature on reducing the wavebreaking amplitude of resonantly driven fields in a spatially inhomogeneous plasma is shown. A simple theory is developed, and some applications to laser plasma interactions are given.

42084 Analytical theory of drift waves and drift-Alfven waves in tokamaks. Lee, Y.C.; Chen, L. (Department of Physics, University of California, Los Angles, California 90024). *Phys. Rev. Lett.;* **42**: No. 11, 708-711(12 Mar 1979).

The collisionless drift wave and drift-Alfven wave instabilities in a sheared magnetic field are considered using the complex transformation technique of Antonsen. It is shown that no unstable bounded eigensolutions for the finite-β radial eigenmode equations exist. We also present a more general technique based on the wave-flux conservation and find, furthermore, that the convective amplification of drift waves in the electrostatic limit can be anomalously large, which could lead to enhanced transport in tokamaks.

42085 Relativistic self-focusing of plasma waves in a cold magnetized plasma. Lominadze, D.G.; Chagelishvili, G.D. (Abastumani Astrophysical Observatory, Academy of Sciences of the Georgian SSR). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **4**: No. 10, 477-478(Oct 1978).

The relativistic self-focusing of waves in a cold plasma containing a fixed magnetic field is examined, it is shown that the effect is due to the anisotropy associated with the magnetic field and the relativistic electron motion. (AIP)

42086 Alfven fluctuations in an inhomogeneous nonequilibrium plasma. Timofeev, A.V.; Meitlis, V.P.; Chulkov, G.N. (I. V. Kurchatov Institute of Atomic Energy, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **4**: No. 5, 603-608(Sep 1978).

The injection of fast ions into a tokamak plasma can cause Alfven waves to grow. If the Alfven velocity varies monotonically in the direction across the magnetic field, there are no unstable resonant waves, and the initial perturbations grow for only a finite time. Then the finite plasma conductivity leads to a damping of these waves. The fluctuations in the electron microcurrents caused by collisions with ions represent an unavoidable source of initial perturbations. Associated with these perturbations is some steady-state level of the fluctuating Alfven waves. This level is determined, and the energy lost by the fast ions due to wave excitation is calculated.

42087 Electromagnetic fields at the constrictions in a plasma pinch. Zhdanov, S.K.; Trubnikov, B.A. (I. P. Kurchatov Institute of Atomic Energy, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **4**: No. 5, 653-654(Sep 1978).

The electric fields are calculated allowing for moving boundary conditions. (AIP)

42088 Scattering of a weak electromagnetic wave by a Langmuir soliton. Sinitsyn, Y.A. (Institute of Radio Physics and Electronics, Academy of Sciences of the Ukrainian SSR, Khar'kov). *Sov. J. Plasma Phys. (Engl. Transl.);* **4**: No. 5, 662-663(Sep 1978).

The Doppler shift and reflection coefficient are calculated. (AIP)

FUSION POWER PLANT TECHNOLOGY

42089 (COO—2456-T1) **High-beta tokamak research: Torus I and Torus II. Quarterly status report, 1 April—30 June 1978.** Marsen, J.; Georgiou, G.; Paul, S. (Columbia Univ., New York (USA). Plasma Lab.). 6 Jul 1978. Contract EY-76-S-02-2456. 4p. Dep. NTIS, PC A02/MF A01.

Experiments on the Torus I belt pinch using a pyrex glass limiter are discussed. The diagnostic equipment is mentioned. Operation of the Torus II in a high-beta mode is described. (MOW)

42090 (COO—2456-T2) **High-beta Tokamak research. Quarterly status report, 1 July—30 September 1978.** Weber, P.G.; Mucha, Z.; Kostek, C.; Kashani, A.; Navratil, G.A.; Marshall, T.C.; Gross, R.A.; Marsen, J.; Georgiou, G.; Paul, S. (Columbia Univ., New York (USA). Dept. of Applied Physics and Nuclear Engineering). 6 Oct 1978. Contract EY-76-S-02-2456. 4p. Dep. NTIS, PC A02/MF A01.

Torus II was operated extensively during the past 3 months. The most important experimental observations are that the heating method for Torus II is working as anticipated and that hot plasma tokamak configurations have been achieved. (MOW)

42091 (EUR—5735, pp 79-123) **Review of experimental results I-II.** Furth, H.P. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). 1978.

From School on tokamak reactors for breakeven; Erice, Italy (21 Sep 1976).

In the first part, an illustrative survey of operating tokamak devices is given. The ohmic heating of tokamak plasmas is reviewed, and the limitations imposed by MHD instability phenomena are described. A modification of the MHD theory, including finite-resistivity effects, appears to give a reasonable fit of experimental results. The combined requirements of ohmic heating, MHD stability, and radiation cooling define the experimental parameters of present-day tokamak devices. In the second part, the experimental results on energy and particle confinement in tokamaks are reviewed. MHD-instability effects on confinement can be distinguished when they are strong, but information on microscopic loss mechanism is still rudimentary. Under the constraint of dominant ohmic heating, the true physical scaling laws of the tokamak transport coefficients cannot be determined. Non-ohmic heating methods, notably neutral-beam injection, are now proving sucessful and should improve our knowledge of tokamak confinement physics. Non-ohmic heating combined with refinements in tokamak geometry offers the prospect of attaining practical tokamak reactor parameters.

42092 (EUR—5735, pp 611-616) **Possible options and strategy of the European Tokamak programme.** Grieger, G. (Commission of the European Communities, Brussels (Belgium)). 1978.

From School on tokamak reactors for breakeven; Erice, Italy (21 Sep 1976).

In this paper the European fusion programme and its probable evolution will be analysed and explained. First, what are the options for such a programme, or better, what potential is available in the European Community as basis for the future evolution of the programme. The answers fall into three categories: 1) Nearly all of the nine member states of the community are running fusion labs, some of them being rather large. The total number of professionals working in these labs is 750. In addition, Sweden has just joined the Community's fusion programme and Switzerland will probably follow soon. 2) Concerning the future reactor technology programme, an even larger number of experienced staff exists in the large fission centres of the Community which, at least in principle, would be very appropriate to take care of many of the technological questions simultaneously with transferring their resources to the fusion programme, and indeed, such a development has started already; and 3) Europe's industry has proved its strength and potential often enough.

42093 (EUR—5735, pp 327) **JET and the Large Tokamak experiments.** Rebut, P.H. (Association Euratom-CEA sur la Fusion, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). 1978.

From School on tokamak reactors for breakeven; Erice, Italy (21 Sep 1976).

42094 (EUR—5791) **JET Project Scientific and technical developments 1976.** (Commission of the European Communities, Luxembourg). 1977. 660p. Dep. NTIS (US Sales Only), PC A99/MF A01.

The JET (Joint European Torus) Project is fully described in EUR 5516e (EUR-JET-R5) 'The JET Project - Design Proposal'. This report describes developments in the project from the stage

described in EUR 5516e until late in 1976. An introductory chapter describes the present state of the project and subsequent chapters deal in detail with the following topics: experimental programme aspects; vacuum vessel, pumping system, activation studies; toroidal field coils and mechanical structure; poloidal field system; assembly and maintenance; power supplies; control and data acquisition system; site and buildings.

42095 (IAEA—207) **Differential and integral nuclear data requirements for shielding calculations.** (International Atomic Energy Agency, Vienna (Austria); Nuclear Energy Agency, 75 - Paris (France)). 1978. 607p. (CONF-761081—). Dep. NTIS (US Sales Only), PC A99/MF A01.

From Specialists meeting on nuclear data requirements for shielding; Vienna, Austria (8 Oct 1976).

Abstracts for each paper have been entered into the data base. (MOW) proposed experimental programme and the possible modes of operation of the device. A detailed account of the project is given in the rest of the report of which Chapters IV and VII comprise the engineering design and the staff and cost estimates respectively.

42096 (N—79-10895) **Evaluation of performance of select fusion experiments and projected reactors. Final report.** Miley, G.H. (Illinois Univ., Urbana (USA)). Oct 1978. 31p. NTIS PC A03/MF A01.

The performance of NASA Lewis fusion experiments (SUMMA and Bumpy Torus) is compared with other experiments and that necessary for a power reactor. Key parameters cited are gain (fusion power/input power) and the time average fusion power, both of which may be more significant for real fusion reactors than the commonly used Lawson parameter. The NASA devices are over 10 orders of magnitude below the required powerplant values in both gain and time average power. The best experiments elsewhere are also as much as 4 to 5 orders of magnitude low. However, the NASA experiments compare favorably with other alternate approaches that have received less funding than the mainline experiments. The steady-state character and efficiency of plasma heating are strong advantages of the NASA approach. The problem, though, is to move ahead to experiments of sufficient size to advance in gain and average power parameters.

42097 (UCRL—81908) **Mirror fusion reactor design.** Neef, W.S. Jr.; Carlson, G.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jan 1979. Contract W-7405-ENG-48. 35p. (CONF-790125—47). Dep. NTIS, PC A03/MF A01.

From 1. topical meeting on fusion reactor materials; Miami Beach, FL, USA (29 Jan 1979).

Recent conceptual reactor designs based on mirror confinement are described. Four components of mirror reactors for which materials considerations and structural mechanics analysis must play an important role in successful design are discussed. The reactor components are: (a) first-wall and thermal conversion blanket, (b) superconducting magnets and their force restraining structure, (c) neutral beam injectors, and (d) plasma direct energy converters.

BLANKET ENGINEERING

42098 (WFPS-TME—79-010) **Stainless steel blanket concept for tokamaks.** Karbowski, J.S.; Lee, A.Y.; Prevenslik, T.V.; Ruck, G.W.; Shannon, T.E. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Fusion Power Systems Dept.; Oak Ridge National Lab., TN (USA)). 25 Jan 1979. Contract EG-77-C-02-4544. 6p. (CONF-790602—32). Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; Atlanta, GA, USA (3 Jun 1979).

The purpose of this joint ORNL/Westinghouse Program is to develop a design concept for a tokamak reactor blanket system which satisfies engineering requirements for a utility environment. While previous blanket studies have focused primarily on performance issues (thermal, neutronic, and structural), this study has emphasized consideration of reliability, fabricability, and lifetime.

MAGNET COILS AND FIELDS

REFER ALSO TO CITATION(S) 42103

42099 (EUR—5735, pp 359-388) **Superconducting magnets. A. Some fundamentals and their state of the art.** Heinz, W. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Abt. fuer Angewandte Systemanalyse; Karlsruhe Univ. (TH) (Germany, F.R.). Inst. fuer Experimentelle Kernphysik). 1978.

From School on tokamak reactors for breakeven; Erice, Italy (21 Sep 1976).

An introduction to the basis of superconductivity is given. Materials suitable for use in superconducting magnets and their essential properties are presented followed by a discussion on the status of conductor development. A survey of stabilization methods, behavior of the superconductor under normal operating conditions and special requirements of superconductors for fusions magnets are given. Magnet technology and its status is briefly discussed. Existing magnet systems are introduced. Finally some of the most important problems encountered in developing big toroidal magnet systems are mentioned.

42100 (EUR—5735, pp 389-448) **Superconducting magnets. B. Superconducting magnet systems in EPR designs.** Knobloch, A.F. (Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)). 1978.

From School on tokamak reactors for breakeven; Erice, Italy (21 Sep 1976).

Tokamak experiments have reached a stage where large scale application of superconductors can be envisaged for machines becoming operational within the next decade. Existing designs for future devices already indicate some of the tasks and problems associated with large superconducting magnet systems. Using this information the coming magnet system requirements are summarized, some design considerations given and in conclusion a brief survey describes already existing Tokamak magnet development programs.

42101 (PPPL—1516) **Time varying eddy currents on a conducting surface in 3-D using a network mesh method.** Christensen, U.R. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Apr 1979. Contract EY-76-C-02-3073. 40p. Dep. NTIS, PC A03/MF A01.

The method presented in this paper was developed for the purpose of analyzing the eddy currents in the TFTR vacuum vessel. The basic principle in this method lies in representing a conducting surface as a network comprised of a number of branches. Each branch has a resistance and a self-inductance as well as mutuals to all other branches. The resulting branch resistance and branch inductance matrices are transformed into mesh matrices by a conventional network procedure. By using these mesh matrices a set of simultaneous differential equations is then established. The eddy currents are then found by using a standard method for solving simultaneous differential equations.

POWER SUPPLIES, ENERGY STORAGE

42102 (ANL/FPP/TM—119) **Power supply requirements for a tokamak fusion reactor.** Brooks, J.N.; Kustom, R.L. (Argonne National Lab., IL (USA)). Feb 1979. Contract W-31-109-ENG-38. 63p. Dep. NTIS, PC A04/MF A01.

The power supply requirements for a 7-M major radius commercial tokamak reactor have been examined, using a system approach combining models of the reactor and poloidal coil set, plasma burn cycle and MHD calculations, and power supply characteristics and cost data. A conventional system using an MGF set and solid-state rectifier/inverter power supplies was studied in addition to systems using a homopolar generator, superconducting energy storage inductor, and dump resistors. The requirements and cost of the power supplies depend on several factors but most critically on the ohmic heating ramp time used for startup. Long ramp times ($\sim > 8$ s) seems to be feasible, from the standpoint of resistive volt-second losses, and would appear to make conventional systems quite competitive with nonconventional ones, which require further research and development.

42103 (EUR—5735, pp 485-509) **Energy sources and conventional magnets.** Selin, K.I. (AFR Sweden; UKAEA, Abingdon. Culham Lab.). 1978.

From School on tokamak reactors for breakeven; Erice, Italy (21 Sep 1976).

A power supply for an EPR toroidal field magnet is described. It is concluded the main network can supply the necessary power estimated to be of the order of 1 GW. The power system response to fault conditions in the experiment is discussed. The utilization of the power dissipated in the magnet is desirable and is referred to in connection with the cooling system arrangements.

42104 (SAND—79-0002, pp 111-146) **Applications: REP-rate pulse power technology.** Feb 1979.

In Particle beam fusion progress report, October 1977—March 1978.

Research on the following topics is discussed: (1) REP-rate pulse power technology, (2) RTF-I, 300-J, 100-pps test facility experiments, (3) transformer development, (4) reactor system studies, (5) general conceptual design, (6) economic considerations, (7) specific reactor designs, (8) low-current density diode physics studies, and (9) plasma injected, microsecond, E-beam diodes. (MOW)

COOLING SYSTEMS

42105 (IAE—2881) **Thermal losses in the high temperature blanket of a thermonuclear reactor.** Murav'ev, E.V. (Gosudarstvennyj

Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 16p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

A simple mathematical model is presented which allows to evaluate the optimal thermal insulation parameters and thermal losses from the high temperature blanket of a thermonuclear reactor into the cooling circuits of relatively "cold" elements of the plant, e.g. of the first wall. The effect of such parameters as insulation thickness and temperature on the level of thermal losses is illustrated by the numerical data. The use of highly effective thermal insulation of the optimum thickness is shown to be necessary.

HEATING AND FUELING SYSTEMS

42106 (LBL—8891) **Multimegawatt neutral beams for tokamaks.** Kunkel, W.B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1979. Contract W-7405-ENG-48. 8p. (CONF-790327—96). Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

Most of the large magnetic confinement experiments today and in the near future use high-power neutral-beam injectors to heat the plasma. This review briefly describes this remarkable technique and summarizes recent results as well as near term expectations. Progress has been so encouraging that it seems probable that tokamaks will achieve scientific breakeven before 1990.

42107 (WFPS-TME—79-008) **Enhanced fuel production in thorium fusion hybrid blankets utilizing uranium multipliers.** Pitulski, R.H.; Chapin, D.L.; Klevans, E. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Fusion Power Systems Dept.; Pennsylvania State Univ., University Park (USA)). 25 Jan 1979. Contract EG-77-C-02-4544. 6p. (CONF-790602—33). Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; Atlanta, GA, USA (3 Jun 1979).

The multiplication of 14 MeV D-T fusion neutrons via (n,2n), (n,3n), and fission reactions by ^{238}U is well known and established. This study consistently evaluates the effectiveness of a depleted (tails) UO_2 multiplier on increasing the production of ^{233}U and tritium in a thorium/lithium fusion—fission hybrid blanket. Nuclear performance is evaluated as a function of exposure and zone thickness.

42108 **Steady-state space charge blowup and recovery of intense ion beams.** Whealton, J.H.; Kelley, G.G.; Morgan, O.B.; Schilling, G. (Oak Ridge National Lab., TN (USA)). *Nucl. Instrum. Methods;* **154**: No. 3, 441-444(1 Sep 1978).

Systems for ion beam blowup and direct recovery are considered, including the effect of electrons in the recovery region. The effect of these electrons is to reduce the space charge limitation of the decelerated beam current and to increase the efficiency of direct recovery. The use of multiple stage recovery devices with magnetic blocking of plasma coupling is proposed to increase the potential recovery of 50 A, 200 kV, 15 cm dia. D^+ beams from about 5%, as predicted without these plasma electrons, to about 70%.

42109 (BNL-tr—672) **Distribution of the flux of charged secondary particles in the cell of the ion optics system of an ion source.** Grigor'yan, V.G.; Latyshev, L.A.; Obukhov, V.A.; Panasenkov, A.A.; Semashko, N.N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1978. Translation of Preprint IAE—3024. 29p. Dep. NTIS, PC A03/MF A01.

An electrolytic bath integrator was used to calculate the ion trajectories. This type of integrator was chosen because the accuracy requirements for calculation of the trajectories of secondary particles may be lower than those for calculation of the configuration of the main beam. An electrolytic bath is particularly suitable for calculations which take into account several options of the shape of the accelerating and extracting electrodes of the ion optics system, for which the configuration of the primary beam remains practically unchanged.

TRITIUM PROCESSING, ENVIRONMENT AND SAFETY

42110 (INIS-mf—4570) **What has the reactor meeting in Hanover brought. A special section on fusion technology - KTG discusses first wall problems.** (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1978. 2p. (In German). Dep. NTIS (US Sales Only), PC A02/MF A01.

The report deals with thermonuclear aspects of the reactor meeting. These aspects concerned the Garching systems studies, safety and environmental problems, radioactive waste in fusion reactor power plants, an intermediate circuit between primary circuit and steam process, structural materials, and a comparison between fast breeders and fusion reactors.

POWER CONVERSION SYSTEMS

42111 **Power flow along a 40-kV multimegawatt neutral beam line.** Menon, M.M.; Dagenhart, W.K.; Davis, R.C.; Gardner, W.L.; Haselton, H.H.; Kim, J.; Ryan, P.M.; Schechter, D.E.; Stirling, W.; Tsai, C.C.; Whealton, J.H. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Appl. Phys.;* **50**: No. 4, 2484-2489(Apr 1979).

The results of a systematic investigation of the power flow along the Oak Ridge National Laboratory/Princeton Large Torus (ORNL/PLT) neutral beam line, using an intense modified duoPIGatron source with a 22-cm active grid diameter and 1799 circular apertures that provide 53% transparency, are reported. The variation of power deposited on the different components of the beam line is measured over a wide range of perveance values. The maximum efficiency for beam power transmitted through a 20 x 25-cm aperture located 4.1 m downstream was found to be 41%. This efficiency was raised to 53% when a voltage of about 175 V was applied to preaccelerate the ions entering the extraction apertures. Transmission efficiencies approaching 60% were obtained using shaped apertures on the plasma grid. Higher efficiencies should be attainable when used for PLT injection since the acceptance angle for the Princeton tokamak is 11% higher than that of the test facility. Detailed analysis of the results using straight circular apertures without precel voltage suggests that the power-deposition profiles have broad wings that significantly affect the transmission efficiency. The results allow optimization of the performance of the beam line and provide guidelines for designing future multimegawatt neutral beam lines.

INERTIAL CONFINEMENT TECHNOLOGY

REFER ALSO TO CITATION(S) 42104

42112 (CONF-790327—100) **Telecoping beams for heavy ion fusion.** Burke, R.J. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 5p. Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

In addition to the strong longitudinal compression and multiple beams now used in all designs for heavy ion fusion drivers, attaining the required beam power could be helped by telescoping bunches of different ion species. Telescoping is here defined as the overtaking and interpenetration of bunches consisting of ions of different species but whose velocity, mass, and charge state have been selected so that the typical ions in the various bunches have the same ratio of momentum to charge, or magnetic rigidity, and, therefore, the same single particle dynamics in transport and focussing lines. With velocities differing by 10% or more, the highest powers would only arise close to the end of the transport lines. Telescoping also increases the total available phase space of the different species. This can be translated to a smaller final momentum spread or a means to accomodate greater phase space dilution.

42113 (CONF-790327—101) **High intensity 1.5 megavolt heavy ion preaccelerator for ion beam fusion.** Watson, J.M./ Bogaty, J.M.; Burke, R.J.; Martin, R.L.; Mazarakis, M.G.; Menefee, K.K.; Parker, E.F.; Stockley, R.L. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 5p. Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

Portions of document are illegible.

A preaccelerator is being developed at Argonne National Laboratory (ANL) in a program to demonstrate the accelerator technology which will be needed for power plants utilizing inertial-confinement fusion (ICF). The preaccelerator has been constructed and is now undergoing performance tests with the initial objective of achieving pulsed 30 mA beams of 1.5 MeV Xe^{+1}. The design, construction, and initial performance of the preaccelerator are described.

42114 (CONF-790327—106) **12.5 MHz heavy ion linac for ion beam fusion.** Moretti, A.; Watson, J.M.; Moenich, J.S.; Foss, M.H.; Khoe, T.K.; Colton, E.P.; Burke, R.J. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 5p. Dep. NTIS, PC A02/MF A01.

From IEEE particle accelerator conference; San Francisco, CA, USA (12 Mar 1979).

Argonne National Laboratory (ANL) is currently developing the injector of a heavy ion beam driver for the inertial confinement fusion program. The first phase of the program is to accelerate about 20 mA of Xe^{+1} from a 1.5 MV preaccelerator 11.4 MeV in a low-beta RF linac. The first section of the linac utilizes a single harmonic buncher and independently-phased short linac resonators with a FODO magnetic quadrupole focusing lattice. These are followed by two double-stub Wideroee linacs. A layout of the linac up to 6.4 MeV is shown. The operating parameters of the low-beta linac are

given. This paper gives details of the low-beta linac design and results of low power measurements on the first accelerating cavity.

42115 (LA—7590-P) **Proposal for the theoretical investigation of light-ion beam propagation through a residual plasma environment.** Thode, L.E.; Lindman, E.L. (Los Alamos Scientific Lab., NM (USA)). Feb 1979. Contract W-7405-ENG-36. 20p. Dep. NTIS, PC A02/MF A01.

In collaboration with the TRW Defense and Space Systems Group, a 22-month investigation of ion beam propagation in residual plasma is proposed by the Los Alamos Scientific Laboratory. We hope to gain insight into the nonlinear physics of microinstabilities associated with a well-collimated ion beam propagating through a plasma, to isolate parameter regimes where problem areas for propagation appear to exist, and to suggest techniques to overcome any problems. A strong interplay between theory and two-dimensional, electromagnetic particle-in-cell simulation is the key to the investigation.

42116 (SAND—79-0002) **Particle beam fusion progress report, October 1977—March 1978.** (Sandia Labs., Albuquerque, NM (USA)). Feb 1979. Contract EY-76-C-04-0789. 156p. Dep. NTIS, PC A08/MF A01.

Separate abstracts were prepared for each of the 6 included sections. (MOW)

42117 (SAND—79-0002, pp 13-28) **Pulsed power research.** Feb 1979.

In Particle beam fusion progress report, October 1977—March 1978.

Important data showing the transport of electrical power in the terawatt range over 6.5 meters with a power transport efficiency of 100 percent and an energy transport efficiency of 90 percent were obtained. These results were required for EBFA and demonstrated the feasibility of the vacuum interface, magnetically insulated line, and diode concept. The MITE (EBFA prototype) continues to function well with a new set of stacked lines simultaneously switching into a common transmission line. The vacuum interface is operating well.

42118 (SAND—79-0002, pp 29-42) **EBFA project.** Feb 1979.

In Particle beam fusion progress report, October 1977—March 1978.

An engineering project office was established during the fall of 1976 to manage and coordinate all of the activities of the Electron Beam Fusion Project. The goal of the project is to develop the Electron Beam Fusion Accelerator (EBFA) and its supporting systems, and integrate these systems into the new Electron Beam Fusion Facility (EBFF). Supporting systems for EBFA include a control/monitor system, a data acquistion/automatic data processing system, the liquid transfer systems, the insulating gas transfer systems, etc. Engineers and technicians were assigned to the project office to carry out the engineering design, initiate procurement, monitor the fabrication, perform the assembly and to assist the pulsed power research group in the activation of the EBFA.

42119 (SAND—79-0002, pp 43-72) **Theoretical research.** Feb 1979.

In Particle beam fusion progress report, October 1977—March 1978.

Theoretical work is reported on the following areas: (1) fusion target physics, (2) standoff and reactor physics, (3) diode physics and power flow theory, (4) diode code development and application, and (5) particle beam source development and theory. (MOW)

42120 (SAND—79-0002, pp 73-96) **Particle beam source development.** Feb 1979.

In Particle beam fusion progress report, October 1977—March 1978.

During the present reporting period we have been able to make significant headway in improving electron beam pinch intensity and efficiency, as well as in the production of intense ion beams. A new cathode design has resulted in attaining 14 - 17 x 10^6 amp/cm^2 on Proto I, and slight modifications to the accelerator, also described, are expected to further enhance this capability. We also report several new schemes for high power current and voltage regulation which may be crucial in future machine designs and are already being used in our accelerator applications. We have shown that ion beam diodes can be used in Proton I to produce proton beams with > 80% of the machine energy, and focused current density in excess of 30 kamp/cm^2 has been obtained in the initial experiments.

42121 (SAND—79-0002, pp 97-110) **Target interaction.** Feb 1979.

In Particle beam fusion progress report, October 1977—March 1978.

Experimental target research is directed towards the development of particle beam driven magnetically insulated targets, the study of particle beam-target coupling, and implosion hydrodynamics. During this reporting period we have strengthened the basis for performing future neutron production experiments with magnetic targets by developing technology to provide high quality targets, and by performing a series of "bench top" experiments to determine the initial conditions of preheat that exist at the time of electron beam irradiation. Implosion physics experiments have been carried out with ablatively driven cylindrical targets on the Hydra accelerator. Development of time resolved neutron diagnostics has continued and new results have been obtained in measurements of 3 ns DT neutron bursts from a REB pulsed neutron source.

42122 **Brillouin backscatter dependence upon pulse amplitudes, timing, target material, and geometry.** Ripin, B.H.; McLean, E. (Naval Research Laboratory, Washington, D.C. 20375). *Appl. Phys. Lett.;* **34**: No. 11, 809-811(1 Jun 1979).

The dependence of stimulated Brillouin backscatter upon pulse amplitudes, timing, target material, and geometry from a prepulse-formed plasma is found. The applicability of these results to backscatter from a structured continuous pulse is discussed.

42123 **Microradiographs of laser fusion targets: 2-D modeling and analysis.** Whitman, R.L.; Day, R.H.; Kruger, R.P.; Stupin, D.M. (University of California, Los Alamos Scientific Laboratory, P.O. Box 1663, Los Alamos, New Mexico 87545). *Appl. Opt.;* **18**: No. 8, 1266-1273(15 Apr 1979).

A new contact microradiographic system for analyzing laser fusion targets with 2-D modeling and image analysis techniques is described. This system, which uses a monochromatic x-ray source and Kodak high-resolution plate emulsion, is sensitive to spherical wall thickness variations (eccentricities) as small as +- 200 A in hollow shells with a mean wall thickness of 1 μm. Measurements of wall thickness and of local and spherical wall thickness variations by radiographic techniques, using 2-D video, digital image analysis, and optical interferometry, are compared.

COMPONENT DEVELOPMENT AND MATERIALS TESTING

42124 (EUR—5735, pp 559-574) **Impact of servicing requirements on Tokamak fusion reactor design.** Mitchell, J.T.D. (UKAEA Research Group, Abingdon. Culham Lab.). 1978.

From School on tokamak reactors for breakeven; Erice, Italy (21 Sep 1976).

There is one design requirement which appears to be common to all D-T fusion reactors, irrespective of the plasma confinement principle embodied in the design. It must be practicable to repair the structure or 'first wall' nearest the plasma. A repair can include a range of operations between finding and sealing a pinhole leak in a weld to complete replacement of the whole structure of the breeding blanket. The two reasons why these repairs are necessary are: 1) The variability and defects in generally perfect products, such as those caused by errors of human performance or by flaws in raw materials. 2) The extreme severity of the environment of the first wall, which causes the deterioration of the properties of materials situated there. This deterioration is the result of neutron irradiation and transmutation in the materials under conditions of stress and high temperature and of surface corrosion and erosion.

42125 (IAEA—207, pp 49-53) **Report of sub-group on fusion reactors.** Dudziak, D.J. 1978.

From Specialists meeting on nuclear data requirements for shielding; Vienna, Austria (8 Oct 1976).

In this paper data needs and recommendations concerning shield design of fusion reactors are presented (neutron, proton and alpha spectra; isotopic data for structural materials, integral and differential cross sections measurements for gas production in structural materials).

42126 (IS-M—194) **Helium gas bubble formation in binary and ternary alloys of vanadium irradiated by energetic Ni^{++} ions.** Schneider, J.G.; Chen, C.W. (Ames Lab., IA (USA)). 1979. Contract W-7405-ENG-82. 5p. (CONF-790125—45). Dep. NTIS, PC A02/MF A01.

From 1. topical meeting on fusion reactor materials; Miami Beach, FL, USA (29 Jan 1979).

Simulation experiments involving He implantation and 4 MeV Ni^{++} ion irradiation were conducted on three binary alloys of V with 5, 10 and 20% Ti and their ternary alloys with Be or Zr up to 1%. All irradiated alloys display He bubbles of varying sizes and densities. The effect of the three solutes, Ti, Be and Zr on bubble formation is to promote nonuniform distribution of bubbles through second phase precipitates. The mechanisms leading to, and the consequence of, close association of bubbles with the precipitates are discussed.

42127 (ORNL-tr—4664) **Study of a tokamak cleaning method utilizing glow discharge.** Brevnov, N.N.; Clausing, R.; Kazachkov, A.A.; Kuznetsov, N.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1979. Translation of IAE—3100. 10p. Dep. NTIS, PC A02/MF A01.

The effect of glow discharge cleaning on the tokamak T-12 wall surfaces and residual gas composition in the apparatus working chamber is experimentally studied. Auger spectroscopy was the diagnostic technique employed. (MOW)

42128 **Superthermal alpha transport and wall bombarment in tokamaks.** Miley, G.H.; Hively, L.M. (Illinois Univ., Urbana (USA). Fusion Studies Lab.). *J. Nucl. Mater.;* **76**: No. 77, 89-395(1978).

From 3. international conference on plasma surface interactions in controlled fusion devices; Abingdon, UK (3 - 7 Apr 1978).

Fusion-product transport, from an axisymmetric tokamak plasma to the first wall, is modelled. Prompt-loss profiles (i.e. prior to slowing) are calculated as a function of poloidal angle. There is a significant flux incident at near-grazing angles, thus enhancing sputtering. Non-prompt losses are also obtained; the resulting wall bombardment is approximately 1/10 of the prompt contribution but is localized at the outboard edge of the tokamak. To verify fusion-product transport, a detection experiment has been proposed and modelled for a device like PLT or TFTR. Blistering is the dominant wall erosion mechanism. Serious impurity contamination of the plasma can result: Δ(Z)sub(eff)/s approximately 6.5 in a TFTR-size device, and 0.014 in UWMAK-I; this poses a potential limit on reaction burn time. These effects can be minimized by: 1) periodic B-field reversal, 2) special wall materials and/or rapid wall replacement design in peak flux areas, 3) increased plasma-wall separation, and 4) increased plasma current.

GENERAL AND MISCELLANEOUS

MATHEMATICS AND COMPUTERS

REFER ALSO TO CITATION(S) 40092, 40185

42129 (ANL/RER—78-3) **User's guide to PLOTIN/MYPLOT. A general-purpose plotting routine for use with AMD graphics.** Toohey, R.E.; Rundo, J.; Kotek, T.J. (Argonne National Lab., IL (USA)). Sep 1978. Contract W-31-109-ENG-38. 102p. Dep. NTIS, PC A06/MF A01.

Topics covered in the user's guide include: use of PLOTIN; additional features afforded by subprograms; job control language; examples; and calling MYPLOT. (GHT)

42130 (CONF-781061—P2) **Proceedings of AESOP-SCIE symposium on advanced computing.** (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1978. Contract W-7405-ENG-48. 111p. Dep. NTIS, PC A06/MF A01.

From AESOP-SCIE symposium on advanced computing; Las Vegas, NV, USA (19 Oct 1978).

The symposium was intended to review the state of advanced computers. The papers presented represent both large and small machines of advanced designs that are currently in the conception, design or initial production stage. Individual items were prepared separately for the data base. (GHT)

42131 (CONF-781061—P2, pp 11-33) **Burroughs scientific processor in perspective.** Fox, J. 1978.

From AESOP-SCIE symposium on advanced computing; Las Vegas, NV, USA (19 Oct 1978).

The BSP uses a large-scale Burroughs B 7700/B 7800 general-purpose computer as a system manager. As a result, the global structure of the BSP itself is simple. It consists of an instruction processor, a set of parallel arithmetic elements, a main memory, an instruction or control memory, and a single I/O device. This I/O device is called file memory. It is controlled by the BSP's instruction processor. It functions as a high-speed I/O device for programs running on the BSP and as a staging point for lower-speed I/O going to or coming from the system manager. The BSP parallel processor has 16 parallel arithmetic elements (AE's) driven in lock-step by a single instruction stream. Hence, the BSP is a single-instruction, multiple-data stream (SIMD) architecture. In this respect, it is comparable with other large pipeline or parallel scientific processors.

42132 (CONF-781061—P2, pp 34-57) **Heterogeneous element processor.** Gilliland, M. 1978.

From AESOP-SCIE symposium on advanced computing; Las Vegas, NV, USA (19 Oct 1978).

HEP is a scalar computer with MIMD (multiple instruction-stream, multiple data-stream) architecture. It can be used in a vector mode by making the instruction streams essentially identical so that it acts like an SIMD (single instruction-stream, multiple data-stream) machine. One main feature of HEP architecture is that it takes full advantage of pipelining without paying the usual penalty for precedence constraints.

42133 (CONF-781061—P2, pp 58-73) **Navier—Stokes solver for the numerical aerodynamic simulation facility.** Bailey, F.R.; Hathaway, A.W. 1978.

From AESOP-SCIE symposium on advanced computing; Las Vegas, NV, USA (19 Oct 1978).

Critical to the advancement of computational aerodynamics capability is the ability to simulate flows about three-dimensional configurations that contain both compressible and viscous effects, including turbulence and flow separation at high Reynolds numbers. While it is currently possible to accomplish this in two dimensions, bridging the gap to three dimensions is beyond the capability of current computers. The Numerical Aerodynamic Simulation Facility (NASF) is proposed to provide this needed increase in computational capability, by carefully matching the characteristics of the problems to be solved with advances in computing system architecture. The NASF Project has been under way for approximately three years, and the remainder of this paper will describe Project activities to date.

42134 (CONF-781061—P2, pp 74) **S-1 project.** Widdoes, L.C. Jr. 1978.

From AESOP-SCIE symposium on advanced computing; Las Vegas, NV, USA (19 Oct 1978).

Data flow concepts have some promise for attaining higher computing speeds on very large problems. This is because data flow techniques of programming permit expressing a large degree of several forms of concurrency. Some data flow concepts are explained, and their applicability to large problems is discussed. Some of the data flow research efforts are surveyed.

42135 (CONF-781061—P2, pp 87-104) **PUMA computer system.** Grishman, R. 1978.

From AESOP-SCIE symposium on advanced computing; Las Vegas, NV, USA (19 Oct 1978).

A high-speed scientific computer system developed and built by the New York University Computer Science Department is described. This system has been dubbed the PUMA Computer System. Officially, PUMA is an acronym for Processing Unit with Microprogrammed Arithmetic, but the name is also intended to convey the grace of its design and the power of the system.

42136 (COO—2482-10) **Construction of well-conditioned systems for Fredholm I problems by mesh adapting.** Hagin, F. (Denver Univ., CO (USA). Dept. of Mathematics). 1979. Contract EY-76-C-02-2482. 31p. Dep. NTIS, PC A03/MF A01.

The numerical solution of linear Fredholm I integral equations of the type arising from various one-dimensional inverse scattering problems is addressed. Typically, when these equations are discretized, they lead to very ill-conditioned algebraic systems. It is shown that for these types of kernels a relatively simple mesh adapting scheme leads to very well-conditioned systems. Moreover, when the kernel is not known explicitly but must be generated by numerically solving a boundary-value problem, it is shown that an asymptotic analysis can extract the information to adapt this mesh successfully. 4 figures, 4 tables.

42137 (COO—3077-151) **PL/I programming language.** Abrahams, P. (New York Univ., NY (USA). Courant Mathematics and Computing Lab.). Mar 1978. Contract EY-76-C-02-3077. 156p. Dep. NTIS, PC A08/MF A01.

PL/I is a large and powerful multipurpose programming language, designed for use in business and in scientific applications as well as in systems programming applications such as writing operating systems. The data types, declarations, expressions, type conversion, and assignment, storage types, procedures, scopes, and environments, on-units and on-statements, other statements affecting flow of control, files and record input—output, and stream input—output are set forth. 9 references. (JFP)

42138 (DP—1489, pp 211-215) **Simple one-dimensional finite element algorithm with multi-dimensional capabilities.** Pepper, D.W.; Baker, A.J. Oct 1978.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1977.

The application of the finite element procedure for the solution of partial differential equations is gaining widespread acceptance. The ability of the finite element procedure to solve problems

which are arbitrarily shaped as well as the alleviation of boundary condition problems is well known. By using local interpolation functionals over each subdomain, or element, a set of linearized algebraic equations are obtained which can be solved using any direct, iterative, or inverse numerical technique. Subsequent use of an explicit or implicit integration procedure permits closure of the solution over the global domain.

42139 (LBL—8276) **Directions for memory hierarchies and their components: research and development.** Smith, A.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1978. Contract W-7405-ENG-48. 8p. Dep. NTIS, PC A02/MF A01.

The memory hierarchy is usually the largest identifiable part of a computer system and making effective use of it is critical to the operation and use of the system. The levels of such a memory hierarchy are considered and the state of the art and likely directions for both research and development are described. Algorithmic and logical features of the hierarchy not directly associated with specific components are also discussed. Among the problems believed to be the most significant are the following: (a) evaluate the effectiveness of gap filler technology as a level of storage between main memory and disk, and if it proves to be effective, determine how/where it should be used, (b) develop algorithms for the use of mass storage in a large computer system, and (c) determine how cache memories should be implemented in very large, fast multiprocessor systems.

42140 (SAND—78-1165) **Input and table-handling facility for fortran programs.** Jones, R.E. (Sandia Labs., Albuquerque, NM (USA)). Mar 1979. Contract EY-76-C-04-0789. 101p. Dep. NTIS, PC A06/MF A01.

This report describes an input and table-handling facility for Fortran programs. This facility, when incorporated into a Fortran program, allows persons preparing input to Fortran programs to use an easy, natural form. It also allows users to input n-dimensional tables in a flexible manner, and allows the Fortran program to use these tables easily. Complete details are given as to how to incorporate this facility into a program, and how to prepare input to be read by this facility.

42141 (UCID—18162) **S.A.M. installation notes.** Ames, H.S.; Morris, W.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Apr 1979. Contract W-7405-ENG-48. 25p. Dep. NTIS, PC A02/MF A01.

The Sample Analysis and Management System (SAM) is a COBOL data management system which executes on a distributed computer network and performs collection, storage and retrieval of some data and the generation of work assignments and completed analysis reports. SAM was written for the U.S. Geological Survey's Analytical Water Analysis Laboratories and utilizes data, general hardware and software. This document contains the detailed instructions needed to install SAM on a multiple computer configuration and a brief description of each of the software modules which comprise SAM.

42142 (UCRL—81493) **Predicting concurrent computer system performance using Petri-Net models.** Cox, L.A. Jr. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1978. Contract W-7405-ENG-48. 25p. (CONF-781218—3). Dep. NTIS, PC A02/MF A01.

From 1978 annual meeting of Association for Computing Machinery; Washington, DC, USA (4 Dec 1978).

The development of a methodology for efficient prediction of concurrent computer performance is described. The initial experiences using the P^4 methodology have shown that performance predictions based on dual Petri-Net representations of hardware and software structures are accurate and efficient in terms of resources required to make the predictions.

42143 (UR—3490-1476) **SKED software system. Revision D. Time-shared SUPERSKED. Manual 3.** Snapper, A.G.; Inglis, G. (Western Michigan Univ., Kalamazoo (USA). Dept. of Psychology; State Systems, Inc., Kalamazoo, MI (USA)). 1977. Contract EY-76-C-02-3490. 203p. Dep. NTIS, PC A10/MF A01.

A modified version of State Notation was developed for both hardware and software design of laboratory procedures involving control sequences that vary as a function of the behavior of the experimental subjects. The SKED program was refined and integrated into the OS/8 and time-share systems developed by DEC to take advantage of the development of mass-storage devices and the sophistication of the operating system. The current system consists of the mass-storage devices and the sophistication of the operating system. The current system consists of a two-pass compiler with an optional third-pass listing, a set of programs for identifying and merging data acquisition files, and a sophisticated system monitor that can be used to start, stop, load, and modify as many as 12 independent process control and data acquisition procedures. CCL was modified to accept standard DEC Execute, Compile, and Load commands with special switch options to control the compiling of procedures designed in state notation. Three different methods are available to acquire data from as many as 12 independent stations. The system includes a parameter file and dialog that permits the user to configure his system. Four different clocks, the UDC controller, EAE units, line-printers and other specialized devices may be included. The available memory may be partitioned between the process control section and the OS/8 background. Finally, the number of digital input and output interface lines may be assigned to 12 stations in a flexible manner, by means of an interactive dialog. The system can be configured on any BK OS/8 machine or in the background. 44 figures, 28 tables.

INFORMATION HANDLING

REFER ALSO TO CITATION(S) 41583, 41633

42144 (CONF-790146—2) **Preparation and publication of a toxic effects document using SAS and COM.** Strand, R.H.; Cushman, R.M.; Hildebrand, S.G.; Anderson, R.M. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 22p. Dep. NTIS, PC A02/MF A01.

From 4. annual SAS User's group conference; Clearwater Beach, FL, USA (28 Jan 1979).

Data were extracted from over 1000 toxicity references for inclusion into a data base with retrieval capabilities. Samples of the data base constituents are presented. A sample program for searching the file is shown. The reduction of a high volume of pages in the report to a microfiche medium is discussed. Reproducing the entire data base with comments, descriptions, and references on a microfiche for portability and accessibility is presented. A sequential filing scheme is used for extending the capability to other data bases.

42145 (DOE/TIC—4585-R1(Suppl.1)) **Energy information data base. Corporate author entries, June 1978—March 1979.** (Department of Energy, Oak Ridge, TN (USA). Technical Information Center). Mar 1979. 40p. Dep. NTIS, PC A03/MF A01.

This supplement contains additions to TID-4585-R1 and is intended to use with that publication. Future supplements will be cumulative from June 1978 until another revision is issued.

42146 (LA-UR—79-487) **Keeping a sense of humor.** Lindberg, H.A. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 6p. (CONF-790509—2). Dep. NTIS, PC A02/MF A01.

From 26. international technical communication conference; Los Angeles, CA, USA (16 May 1979).

New technical editors face many problems that are not discussed in college textbooks. While working within the management structure, they must analyze the needs of their organization, be sensitive to individual personalities, innovate, and gain acceptance for new and more efficient ways of producing written communications. This paper describes some simple and pratical ideas from the experiences of a new technical editor for working successfully with authors and management to improve attitudes toward written presentations. These concepts can help the technical editor to increase the quality and accelerate the production of written communications from draft to printed copy while maintaining a civil relationship with authors and keeping a sense of humor.

42147 (ORNL/CSD/TM—80) **National library of medicine toxicology data base data management system.** Stanton, J.S.; McNeany, J.L. (Oak Ridge National Lab., TN (USA)). Apr 1979. Contract W-7405-ENG-26. 44p. Dep. NTIS, PC A03/MF A01.

A data management system developed for the National Library of Medicine (NLM) Toxicology Data Base (TDB) is described in this document. The TDB data management system includes features to handle initial data entry, data editing, generation of proof listings, and conversion of data to and from the MARK IV file management system's input format. The TDB data management system is installed on the DECsystem-10 computer at the Oak Ridge National Laboratory.

42148 (PNL—2850(Pt.3), pp 1.33-1.35) **Graphical interpretation of numerical model results.** Drewes, D.R. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

Computer software has been developed to produce high quality graphical displays of data from a numerical grid model. The code uses an existing graphical display package (DISSPLA) and overcomes some of the problems of both line-printer output and traditional graphics. The software has been designed to be flexible enough to handle arbitrarily placed computation grids and a variety of display requirements.

42149 (PNL—2850(Pt.3), pp 2.20-2.21) **Testing and documentation of programs used to transform climatological precipitation data to a geographically gridded format.** Fox, T.D. Feb 1979.

In Pacific Northwest Laboratory annual report for 1978 to the DOE Assistant Secretary for Environment. Part 3. Atmospheric sciences.

A procedure was developed for converting climatological hourly precipitation data into a form suitable for input to regional atmospheric transport and removal models. The procedure involves a rearrangement of the original data by date rather than by station, followed by the use of a spatial averaging scheme to interpolate data from randomly spaced stations to a regularly spaced grid. The procedure has been tested and documented for general use.

CIVILIAN DEFENSE

42150 (AD-A—060315) **The applicability of satellite technology to defense civil preparedness. Final report.** (Comsat General Corp., Washington, DC (USA)). 30 Jun 1978. Contract DCPA01-77-C-0239. 96p. NTIS PC A05/MF A01.

This study assesses the applicability of satellite technology to the DCPA mission. Surveys of currently-available and planned communication and remote sensing satellite systems are presented. A section on post-nuclear-blast propagation conditions is included. Conceptual satellite network plans, one based on a dedicated network and one on commercial transponder leasing, are developed, leading to a plan for a preliminary Demonstration Network. The study concludes that a satellite-based Civil Preparedness Communication Network could support both peacetime and disaster-oriented requirements practically; that the use of remote sensing for resource data base inventorying is presently inadvisible; that the 6/4 GHz band offers the best technical and most cost-effective means for initial implementation; and that use of remotely-located Sensor Monitor Terminals to collect and transmit radioactive fallout data to a central processing facility is feasible.

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DOE Energy Information Data Base: Corporate Author Entries (TID-4585) is used in the standardization of corporate entries. TID-4585 is available for purchase from the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, Virginia 22161.

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Title, (supplementary information), citation number, (report number)

The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

Index entries are selected to indicate the important ideas and concepts presented in a document, rather than words that may appear in the text. Within the available thesaurus terms, the most probable or logical place to look for typical information is selected. "See references" are included to guide users from synonymous terms or phrases to the descriptor selected as a subject heading for the concept. (e.g. Pipeline Quality Gas see HIGH BTU GAS). "See also references" are used to indicate where to find references to subject concepts that are narrower, broader, or related to a particular subject heading. To complete an exhaustive search of a given subject, all such headings should be reviewed.

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CONF-790224-		(Workshop on passive solar design, Perth, Australia, 23 Feb 1979)
1	4:40553	*See* LA-UR-78-427
CONF-790225-		(International cadmium conference, Cannes, France, 6-8 Feb 1979)
1	4:41765	*See* BNL-25707
CONF-790227-		(International workshop on short-term tests for prescreening of potential carcinogens, Genoa, Italy, 6-8 Feb 1979)
1	4:41758	Dep. NTIS, PC A02/MF A01
2	4:41759	Dep. NTIS, PC A02/MF A01
CONF-790229-		(32. annual symposium on fundamental cancer research, Houston, TX, USA, 27 Feb-2 Mar 1979)
3	4:41739	Dep. NTIS, PC A03/MF A01
CONF-790305-		(ASME gas turbine closed-cycle session, San Diego, CA, USA, 11-15 Mar 1979)
5	4:40516	*See* COO-4094-32
8	4:40130	Dep. NTIS, PC A02/MF A01
CONF-790306-		(International conference on fast breeder reactor performance, Monterey, CA, USA, 5-8 Mar 1979)
7	4:40950	*See* HEDL-SA-1526-FP
8	4:40843	*See* HEDL-SA-1518
13	4:40844	*See* HEDL-SA-1527-FP
CONF-790310-		(Specialists workshop on predictive analysis of material dynamics in LMFBR safety expts, Los Alamos, NM, USA, 13-15 Mar 1979)
4	4:40967	*See* SAND-78-1910C
5	4:40845	*See* HEDL-SA-1631-FP
CONF-790313-		(NACE/Corrosion 1979 meeting, Atlanta, GA, USA, 12-16 Mar 1979)
2	4:41267	Dep. NTIS, PC A02/MF A01
CONF-790316-		(Topical seminar on the practical implications of the ICRP recommendation and the revised IAEA basic standards for radiation protection, Vienna, Austria, 5-9 Mar 1979)
1	4:41752	*See* UCRL-81774
2	4:41734	Dep. NTIS, PC A02/MF A01
CONF-790321-		(2. international symposium on radiopharmaceuticals, Seattle, WA, USA, 18-23 Mar 1979)
5	4:41386	*See* BNL-25802
CONF-790323-		(Symposium on high spin phenomena in nuclei, Argonne, IL, USA, 15-17 Mar 1979)
4	4:41935	*See* LBL-8965
CONF-790326-		(Conference on basis two-phase flow modeling in reactor safety and performance, Tampa, FL, USA, 2 Mar 1979)
1	4:40876	*See* LA-UR-79-483
CONF-790327-		(IEEE particle accelerator conference, San Francisco, CA, USA, 12-14 Mar 1979)
88	4:41504	*See* LBL-8409
89	4:41490	*See* LBL-8809
90	4:41497	*See* LBL-8908
93	4:41491	*See* LBL-8951
94	4:41535	*See* LBL-8961
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129	4:41499	Dep. NTIS, PC A02/MF A01
CONF-790328-		(Solar energy storage options workshop, San Antonio, TX, USA, 18-20 Mar 1979)
3	4:40552	*See* COO-4704-2
5	4:40574	*See* DOE/NASA/1034-79/2
CONF-790337-		(New fuels and advances in combustion technologies symposium, New Orleans, LA, USA, 26-30 Mar 1979)
4	4:40789	Dep. NTIS, PC A02/MF A01
CONF-790338-		(3. EPA stationary source combustion symposium, San Francisco, CA, USA, 5-8 Mar 1979)
1	4:40200	Inst. of Gas Technology, Chicago, IL

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CONF-790341-		(International conference on modulated structures, Kailua-Kona, HI, USA, 22-25 Mar 1979)
6	4:41212	*See* BNL-25917
CONF-790345-		(Workshop on solar energy storage, Chandigarh, India, 9-11 Mar 1979)
1	4:41001	Dep. NTIS, PC A02/MF A01
CONF-790346-		(Conference on conservation: energy management by design, El Paso, TX, USA, 8 Mar 1979)
1	4:41134	*See* LA-UR-79-625
CONF-790347-		(2. international conference on meson-nuclear physics, Houston, TX, USA, 5-9 Mar 1979)
8	4:41895	*See* BNL-25961
CONF-790353-		(IECI 1979 conference on industrial and control application of microprocessors, Philadelphia, PA, USA, 19-21 Mar 1979)
2	4:40545	*See* COO-4094-34
CONF-790356-		(European committee on surface science II, Cambridge, UK, 26-29 Mar 1979)
1	4:41239	*See* BNL-25912
CONF-790361-		(LMFBR workshop, Albuquerque, NM, USA, 12-15 Mar 1979)
1	4:40935	Dep. NTIS, PC A02/MF A01
CONF-790401-		(District heating coal generation symposium, Minneapolis, MN, USA, 2-3 Apr 1979)
1	4:41045	Dep. NTIS, PC A02/MF A01
CONF-790405-		(AICE meeting, Houston, TX, USA, 1-5 Apr 1979)
16	4:40081	Dep. NTIS, PC A03/MF A01
CONF-790413-		(International solar-terrestrial predictions workshop, Boulder, CO, USA, 23-27 Apr 1979)
3	4:40507	*See* LA-UR-79-673
CONF-790415-		(177. ACS national meeting, Honolulu, HI, USA, 1-6 Apr 1979)
17	4:40646	Dep. NTIS, PC A02/MF A01
CONF-790420-		(International symposium on ceramics in nuclear waste management, Cincinnati, OH, USA, 30 Apr-2 May 1979)
10	4:40415	Dep. NTIS, PC A02/MF A01
11	4:41289	*See* COO-1198-1261
CONF-790423-		(2. multiphase flow and heat transfer symposium workshop, Miami Beach, FL, USA, 16-18 Apr 1979)
10	4:40936	Dep. NTIS, PC A02/MF A01
CONF-790429-		(4. specialist meeting on fuel-coolant interaction in nuclear reactor safety, Bournemouth, UK, 2-5 Apr 1979)
2	4:40968	*See* SAND-79-0740C
CONF-790430-		(1. annual symposium on safeguards and nuclear material management, Brussels, Belgium, 25-27 Apr 1979)
3	4:40459	*See* LA-UR-79-1023
4	4:40458	*See* LA-UR-79-1022
6	4:40368	*See* LA-UR-79-1020
11	4:40460	*See* LA-UR-79-1073
12	4:40461	*See* LA-UR-79-1074
13	4:40463	*See* UCRL-81949
CONF-790440-		(12. oil shale symposium, Golden, CO, USA, 18-20 Apr 1979)
1	4:40335	*See* SAND-79-0041C
CONF-790441-		(ANS topical meeting on light water reactor fuel performance, Portland, OR, USA, 29 Apr-2 May 1979)
2	4:40900	Dep. NTIS, PC A02/MF A01
3	4:40937	Dep. NTIS, PC A02/MF A01
CONF-790442-		(International conference on metallurgical coatings, San Diego, CA, USA, 23-27 Apr 1979)
2	4:41292	*See* SAND-79-0045C
5	4:40357	*See* NLCO-1153
9	4:41291	*See* SAND-78-2071C
CONF-790445-		(19. annual meeting of the institute of environmental sciences, Seattle, WA, USA, 29 Apr-2 May 1979)
1	4:40323	*See* UCRL-81812
CONF-790446-		(4. annual heat pump technology conference, Stillwater, OK, USA, 9-10 Apr 1979)
2	4:40550	*See* BNL-25928
CONF-790447-		(Health implications of the new energy technologies, Park City, UT, USA, 4-7 Apr 1979)
2	4:41763	Dep. NTIS, PC A03/MF A01
3	4:40338	*See* LA-UR-79-1014
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1	4:40082	Dep. NTIS, PC A02/MF A01
CONF-790460-		(Society of Petroleum Engineers California regional meeting, Ventura, CA, USA, 18-20 Apr 1979)
2	4:40283	*See* SAND-79-0821C
CONF-790505-		(25. ISA international instrumentation symposium, Anaheim, CA, USA, 7-9 May 1979)
8	4:40938	Dep. NTIS, PC A02/MF A01
10	4:40549	*See* SAND-79-0697C
13	4:41559	*See* LA-UR-79-548
CONF-790507-		(IAEA symposium on physics and chemistry of fission, Julich, F.R. Germany, 14-18 May 1979)
2	4:41964	Dep. NTIS, PC A02/MF A01
3	4:41970	*See* IAEA-SM-241-D1
CONF-790509-		(26. international technical communication conference, Los Angeles, CA, USA, 16-19 May 1979)
2	4:42146	*See* LA-UR-79-487
CONF-790517-		(24. annual SAMPE symposium, San Francisco, CA, USA, 8-10 May 1979)
1	4:40569	*See* SAND-79-0215C
CONF-790518-		(10. US/UK symposium on neutron generators, Albuquerque, NM, USA, 21-25 May 1979)
4	4:41336	*See* SAND-79-0605c
5	4:41334	*See* SAND-79-0158C
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1	4:40495	*See* UCRL-82434
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3	4:41140	*See* LBL-8828
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2	4:41374	*See* BNL-26072
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2	4:41392	*See* SAND-78-2350C
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1	4:41290	*See* IS-M-196
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2	4:40818	*See* BNL-26016
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4	4:40912	*See* BNL-NUREG-25575
6	4:40913	*See* BNL-NUREG-25617
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3	4:41566	*See* UCRL-81657
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8	4:40333	*See* SAND-79-0563C
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1	4:41574	*See* SAND-78-2045C
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1	4:41390	*See* LA-UR-78-3169

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2	4:41451	*See* SAND-79-0209C
CONF-790615-		(3. US national congress on pressure vessels and piping, San Francisco, CA, USA, 25-29 Jun 1979)
1	4:41391	*See* SAND-78-2336C
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7	4:40904	Dep. NTIS, PC A02/MF A01
10	4:40746	*See* LA-UR-79-679
CONF-790616-		(Conference on irradiation behavior of metallic materials for fast reactor core components, Ajaccio, France, 4 Jun 1979)
1	4:41274	*See* GEFR-SP-153
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1	4:41197	*See* BDX-613-2133
CONF-790619-		(3. IMACS international symposium on computer methods for partial differential equation, Bethlehem, PA, USA, 20-22 Jun 1979)
1	4:42000	*See* LA-UR-79-837
CONF-790622-		(Pulsed power conference, Lubbock, TX, USA, 12-14 Jun 1979)
1	4:41539	*See* UCRL-82533
CONF-790625-		(14. carbon conference, University Park, PA, USA, 25-29 Jun 1979)
1	4:41333	*See* Y/DA-8065
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2	4:40095	*See* UCRL-82673
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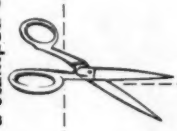

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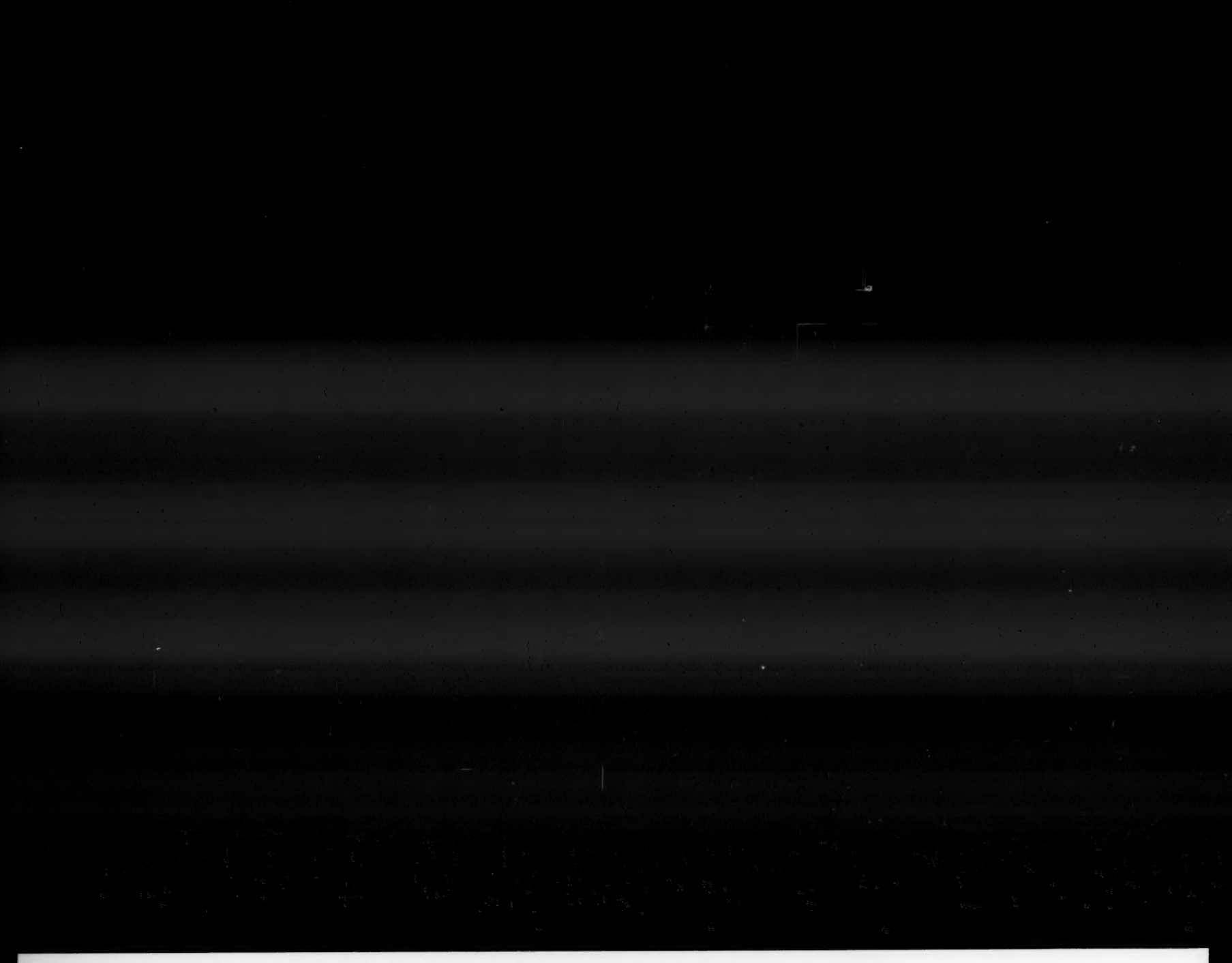
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